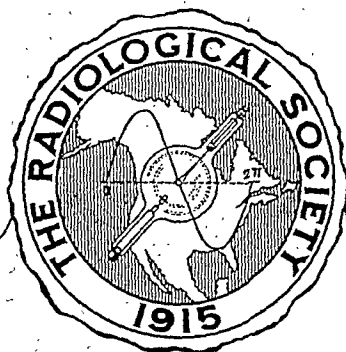




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# RADIOLOGY

A MONTHLY JOURNAL DEVOTED  
TO CLINICAL RADIOLOGY AND  
ALLIED SCIENCES



JULY · 1938

VOLUME 31

NUMBER 1

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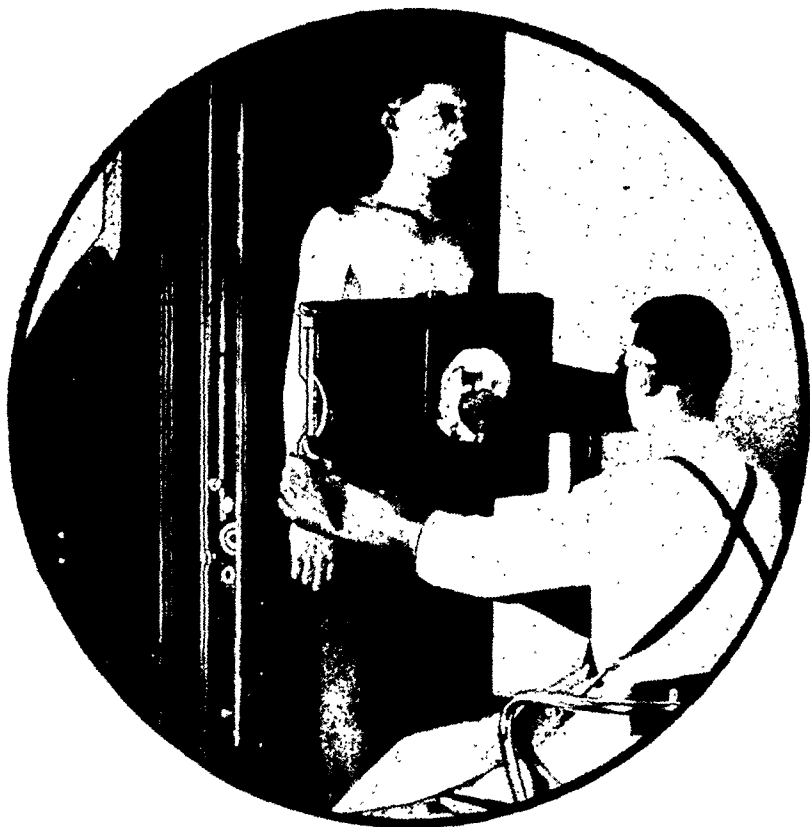
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VOL. 31

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No. 1

## THORACIC SERIOSCOPY<sup>1</sup>

METHOD OF STUDY FOR PLEURO-PULMONARY LESIONS

By DR. PAUL COTTENOT, *Paris, France*

TRANSLATION BY A. U. DESJARDINS, M.D., THE MAYO CLINIC, ROCHESTER, MINN.

SERIOSCOPY of the thorax, according to the method which I have perfected, consists in taking, under specified conditions, four stereoscopic roentgenograms of the thorax. The four films are examined while superimposed one over the other in the same negative viewing box. By causing them to slide synchronously one over the other, the different thoracic planes, superimposed from the front backward, are successively brought into evidence, and at the same time one reads on a dial graduated in centimeters the depth of each of the planes examined.

### PRINCIPLE OF SERIOSCOPY

The principle of this general method of examination, conceived by Ziedses des Plantes, is made clear by the accompanying optical diagram (Fig. 1). Let us suppose that a stereoscopic roentgenogram is made of two grains of lead, *A* and *B*, placed at different depths with relation to the plate (or film). With the anti-cathode at *F*<sub>1</sub> we have on one of the films two images, *a*<sub>1</sub> and *b*<sub>1</sub>; when the anti-cathode is shifted to the position *F*<sub>2</sub> we find on the second film two images—*a*<sub>2</sub> and *b*<sub>2</sub>. With

the two films superimposed as in the figure, if they are made to slide one on the other in the direction of the arrows, *a*<sub>1</sub> and *a*<sub>2</sub> are first brought into coincidence to yield a clear image of *A*; at this moment only the points included in the plane passing through *A* and parallel to the film give a clear image. It is only with a greater displacement that *b*<sub>1</sub> and *b*<sub>2</sub> can be brought into coincidence to yield a clear image of *B* and of the plane passing through *B*. The degree of displacement is related to the distance between the object and the plate (or film).

This distance can readily be evaluated in centimeters (See Fig. 2). On the left side of the diagram is represented a scale composed of a block of wood in which are included lead figures superimposed at a distance of one centimeter one from the other. Let us assume that the figure 8 is comprised in the plane passing through *A*, and the figure 4 in the plane passing through *B*; at the moment when *a*<sub>1</sub> and *a*<sub>2</sub> are in coincidence, the two figures, 8 and 8<sub>2</sub>, are also in coincidence, giving a clear image of the figure 8. The same is true for figure 4 which is clearly defined when *b*<sub>1</sub> and *b*<sub>2</sub> coincide. Thus, at the moment when we can clearly see a lesion in the negative viewer, we can read simultane-

<sup>1</sup>Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.



ously the distance in centimeters which separates the lesion from the film.

In practice, in order to obtain a clear image of a single plane, the other planes yielding blurred and undiscernible images,

to take the successive roentgenograms at exactly the same moment of respiration.

My "cardio-respiratory selector" has enabled me to do this very simply because its object is, precisely, to take in succession

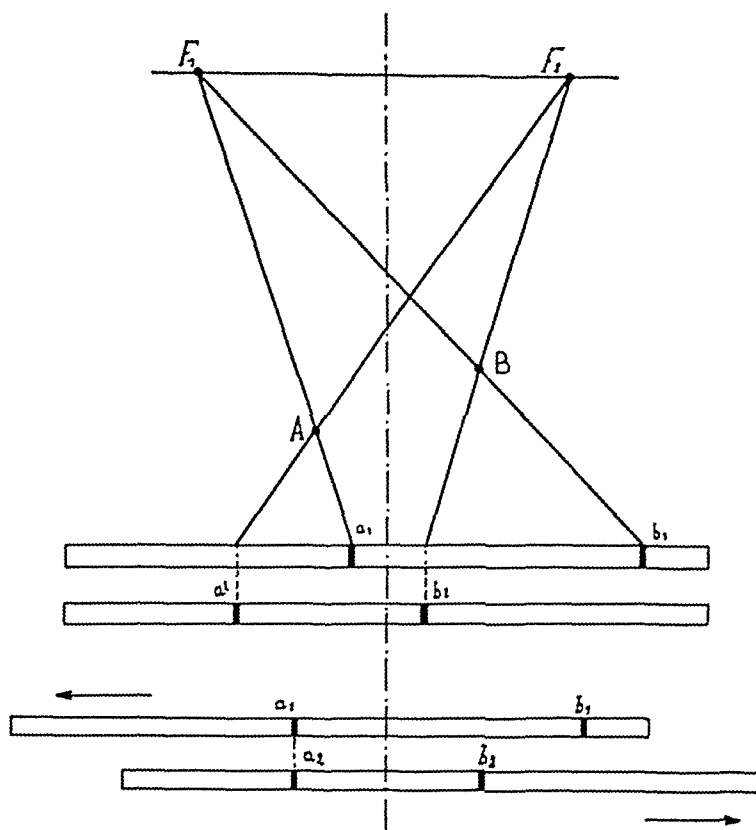


Fig. 1.

a single stereoscopic roentgenogram is not sufficient; two pairs of stereo-roentgenograms should be taken in succession, with the axes of shift of the tube perpendicular to one another.

#### THORACIC SERIOSCOPY

The plane by plane study of lesions of the respiratory apparatus and the determination of their depth have seemed to me the most valuable indications for serioscopy, but the thorax offers for this method a special difficulty by reason of the variation in its form and volume during respiration. It is impossible to prolong respiratory apnea sufficiently to allow the taking of the four films, yet it is essential

many roentgenograms at the same time of respiration or during a cardiac cycle, the patient being fitted with a pneumatic belt which, on respiration, governs the taking of the roentgenogram at the chosen moment. But since it comprises an amplifier, this apparatus is slightly complicated. Pulmonary serioscopy can utilize a more simple apparatus. For the latter method, therefore, I have had constructed a very simple "respiratory trigger" (Fig. 3).

This device comprises a U-shaped mercury manometer, the two branches of which are of different caliber. The larger branch receives the pressure variations of a pneumatic belt fitted to the patient. In the smaller branch are produced oscillations

of the column of mercury which are synchronous with the movement of respiration. A metal rod extends into the tube and, by means of a rack and pinion, this rod can be pushed down, more or less, into the tube;

the patient to breathe freely while observing the oscillations of the mercury column which are made clearly visible by special lighting. At the moment when the mercury has left the contact rod, it is only

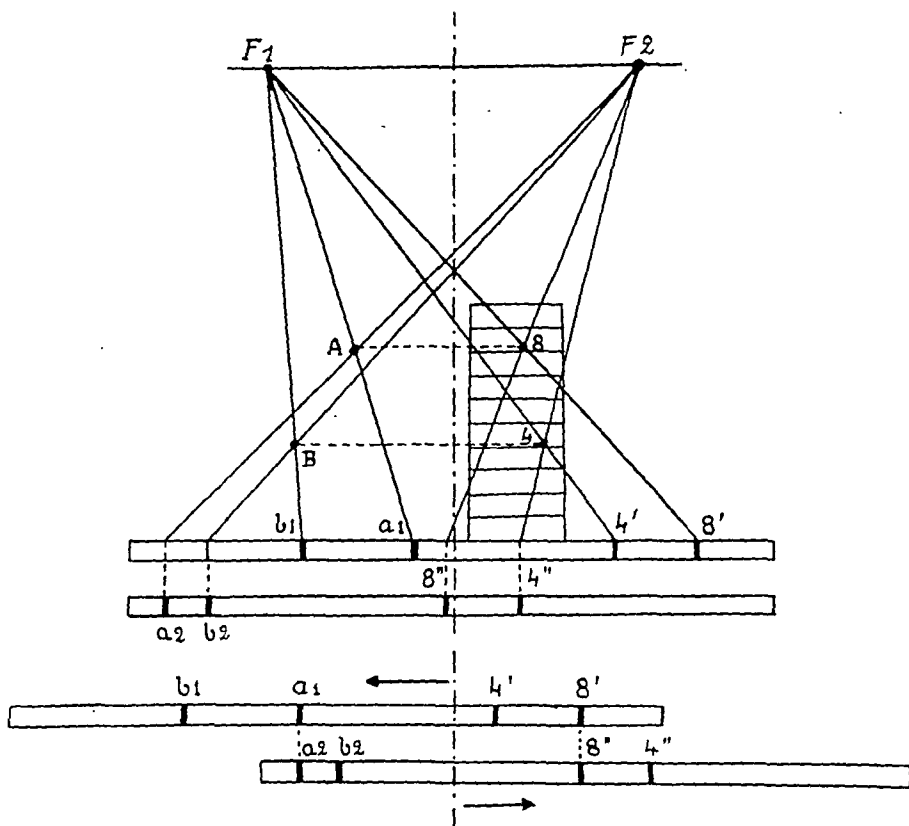


Fig. 2.

an electrical contact is thus established in a system supplied by the circuit, and this comprises a compacity connected in series with a metal oxide rectifier.

A sensitive relay mounted in series with the contact of the mercury manometer transmits the impulses to the trigger circuit of the roentgenologic apparatus through a locking relay. The purpose of the latter is to prevent any further release after the film has been taken.

To use the apparatus all that is necessary is to regulate the position of the metal rod so that electrical contact will be made at the selected moment of inspiration. Once this has been set, it is sufficient to allow

necessary to press on a rubber bulb to close the circuit for the roentgenogram to be made at the following inspiration, at the moment when the next electrical contact will be made. Thus many successive roentgenograms can be taken at precisely the same moment of inspiration.

In addition to the foregoing, the apparatus also comprises an inverter which, by suitable setting of the contact rod, would permit the film to be taken at the end of expiration.

#### TECHNIC OF FILM EXPOSURE

The patient, fitted with the pneumatic belt connected to the release, is placed in a

standing position as for an ordinary thoracic roentgenogram, behind the usual vertical chassis and is immobilized by a strap and

first two, and in the vertical plane for the last two.

As has already been pointed out, quiet

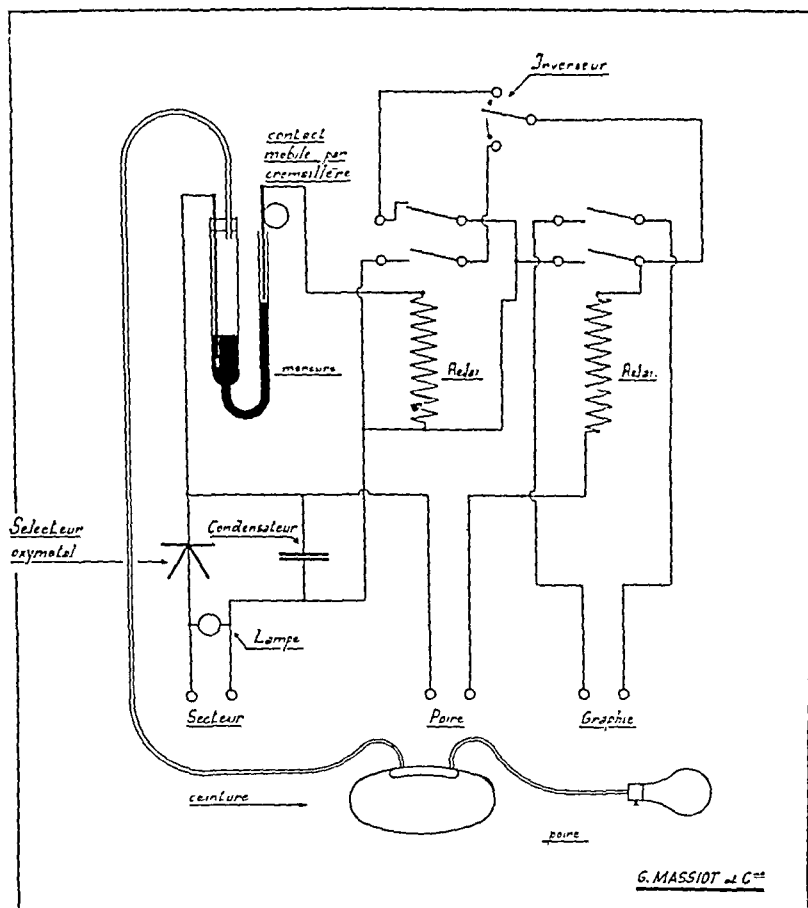


Fig. 3. Mounting diagram of the respiratory release of Cottenot.

by two arms with pads pressing against the shoulders (Fig. 4). The chassis is equipped with: (1) a bakelite plate inserted in the bottom of the cassette carrier, bearing two grains of lead, the image of which will serve as film indicators; (2) stops for the horizontal and vertical shifts of the tube.

After roentgenoscopic centering, the four roentgenograms are taken at a distance of 1.40 meters, the tube being successively shifted 14 cm. to the right, to the left, upward, and downward. The films, 30 × 40 cm. in size, are arranged with the maximum diameter in the horizontal plane for the

respiration on the part of the patient operates the release; the exposure for each film is one-third of the normal exposure; it is, therefore, very short, being approximately 0.5 second.

#### EXAMINATION OF THE SERIAL FILMS

The serioscope on which the films are examined is a negative viewing device with powerful lighting, and on which slide four film carriers with synchronous and symmetrical displacement. One of the films is fixed on each of the carrier slides (Fig. 5). Thus, by the turn of a screw, the four films superimposed in the negative viewer can

slide one over the other in synchronism, each film being displaced in the same direction as that of the tube during exposure of standardization of the serioscope (for a focal distance of 1.40 meters and a shift of 14 cm.). The dial has thus been graduated



Fig. 4. The taking of a thoracic serioscopy.

the film (to right, to left, upward, and downward).

The screw which governs the shifting of the films also moves a needle in front of a dial, and the serioscopic examination of the scale with lead numbers has permitted

in centimeters. The films are mounted on the serioscope in such manner that, with the needle at zero, the four images of two grains of lead arranged at the bottom of the cassette carriers coincide. By turning the shift screws we can explore successively an

infinity of thoracic planes superimposed from the front backward through the entire depth of the thorax, each plane ex-

can accurately select the best surgical approach and may learn the depth at which the lesion may be encountered.

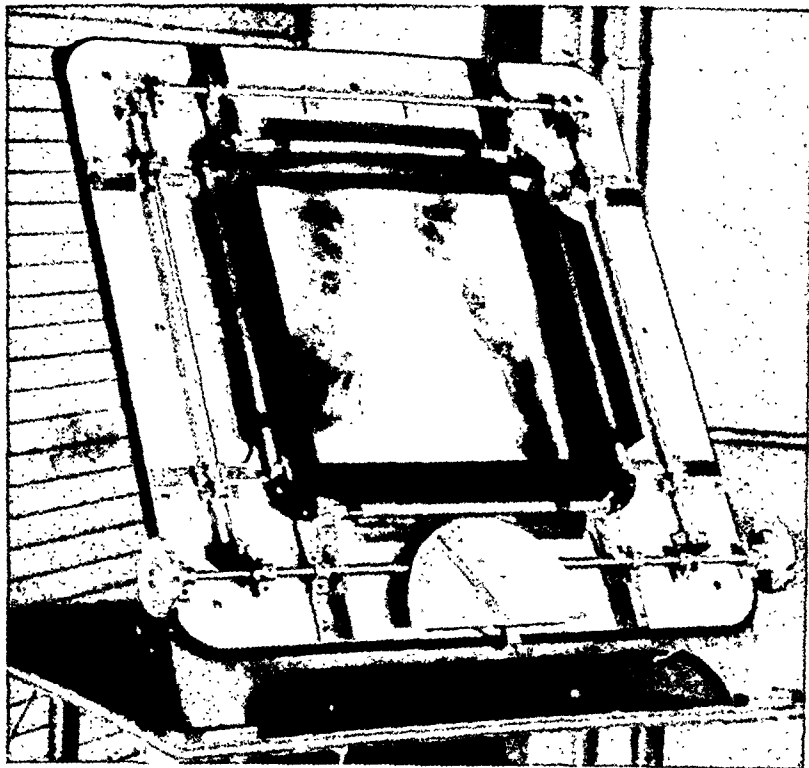


Fig. 5. Four films mounted in the serioscope.

amined giving a clear image while the other planes are blurred, and the needle indicates in succession the depth of the explored planes.

#### RESULTS OF THORACIC SERIOSCOPY

Serioscopy is interesting from two points of view: (1) it enables one to recognize and to identify lesions of the pleura or lung, which simple roentgenography does not bring out clearly; (2) it automatically gives in centimeters the distance which separates the lesion from the thoracic walls,—valuable information for the surgeon who must operate for an abscess of the lung, perform a thoracoplasty for tuberculous cavitation, or separate adhesions in pneumothorax.

Thus in cases encountered so frequently, in which silhouette roentgenography yields only uncertain information, the surgeon

Some cases examined are as follows:

*Tuberculous Foci.*—(a) Silent cavity, expectoration of bacilli, doubtful roentgenography; serioscopy showed the cavity. (b) Expectoration of bacilli, negative auscultation; roentgenography showed the indefinite image of a cavity near the hilus. Serioscopy revealed the cavity, far back, behind the pulmonary vessels. (c) Expectoration of bacilli, negative auscultation; the roentgenographic appearances were uncertain. Serioscopy showed a tuberculous focus situated behind the left ventricle of the heart.

*Pneumothorax.*—(a) Serioscopy reveals a cavity situated in the lower lobe of the left lung. (b) Tuberculosis with cavitation. The first-stage of a thoracoplasty has been performed. Before the second-stage operation, the surgeon wanted to know the dimension and the situation of the cavity.

Serioscopy showed the very elongated cavity occupying the whole depth of the thorax (Fig. 6). (c) Right pneumothorax with apical adhesion. The adhesion is situated 6 cm. behind the clavicle, 4 cm. in front of the posterior costal arches, and has within it an elliptical cavity.

*Abscess of the Lung.*—Three abscesses about which profile roentgenography did not furnish any information. Serioscopy made it possible to localize them. (a) Abscess of the left lung shaped like a "brioche," 1 cm. from the anterior thoracic wall. Result confirmed by the surgeon. (b) Abscess in the right axillary region. Roentgenography did not show any cavity. Serioscopy showed three cavities and localized the abscess 14 cm. from the anterior wall, 3 cm. from the posterior wall. Healed without operation. (c) Abscess at the right base; serioscopy showed it far posteriorly, 2 cm. from the posterior wall; and this was confirmed by the surgeon.

*Hydatid Cysts.*—Two hydatid cysts of the right lung, with fluid level. These levels were in the case of the external cyst (posterior), 2 cm. from the posterior wall, and in the case of the internal cyst 5 cm. from the posterior wall.

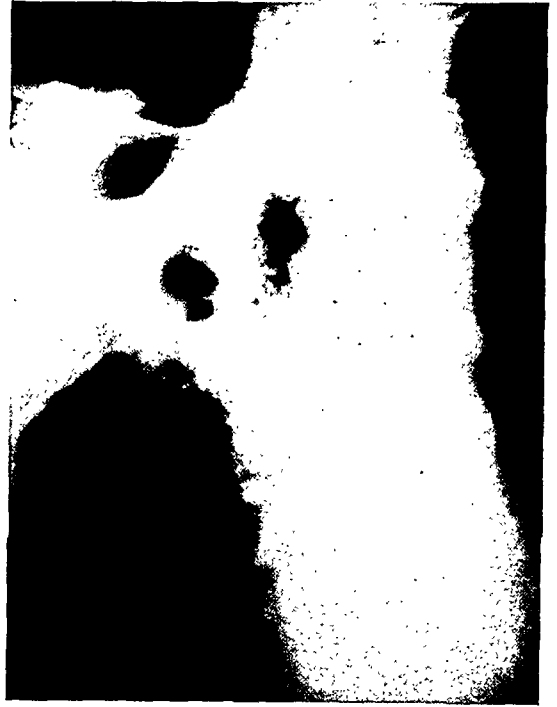


Fig. 6. Serioscopy of a bilobed cavity after the first stage of a thoracoplasty; the plane of view passes 3.5 cm. from the posterior thoracic wall.

*Hyperostosis of a Rib.*—Anterior roentgenography showed a small, round shadow invisible in profile. Serioscopy shows that the hyperostosis affects the inferior border of the eighth rib on the right side.

## X-RAY DIAGNOSIS OF COMPLETE AND PARTIAL ACUTE INTESTINAL OBSTRUCTION

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From the Department of Radiology, Jewish Hospital

THE successful treatment of acute intestinal obstruction is directly proportional to the frequency of early diagnoses. We believe that the radiologist is in a position to diagnose correctly early cases of obstruction when the clinician may be in doubt even after thorough physical examination. Normal digestion and assimilation are interfered with in ileus by an alteration of peristalsis, secretion, and absorption; this is productive of accumulation of gas and fluid in the obstructed loops, with a resultant characteristic roentgenographic appearance of the abdomen on scout x-ray films. Seulberger, Brandes, and Roth (10) have shown experimentally that there is decreased absorption from the intestinal tract in ileus due to the hypertonicity of the bowel contents. Increased secretion, decreased absorption, and blocking of the intestinal contents in its passage to the colon account for intestinal distention in both mechanical and adynamic ileus. Ochsner (8) has proven that strangulated obstruction can be demonstrated by x-ray in one hour and a simple obstruction within three hours. According to the author, accumulation of gas is the first sign rather than gas and fluid. The films of approximately one hundred patients with symptoms of an acute "surgical belly" were studied. They naturally fell into the following group classifications: acute complete intestinal obstruction of small bowel; partial intestinal obstruction of small bowel; acute complete intestinal obstruction of colon; partial intestinal obstruction of colon; dynamic ileus (pre- and post-operative); control group (biliary colic, renal colic, acute appendicitis, etc.).

The anatomical distribution and grouping of coils of the small intestines, based on the embryonic studies of Mall and the clinical and radiologic work of Lewis

Gregory Cole (3), fall into six divisions. (The small intestine begins with the duodenum and ends at the ileocecal valve.) The six groups are as follows: (1) The duodenum—situation largely retroperitoneal; (2) lies in the left hypochondrium and assumes a transverse direction; (3) lies transversely in the left lumbar within the pelvis; (4) lies vertically in the umbilical and upper hypogastrium; (5) lies vertically in the right lumbar area; (6) lies vertically in the right iliac fossa, false pelvis, and lower hypogastric area.

It is quite evident that, in any such grouping, owing to the massing, general distention, and displacement of the loops, picking the site of the obstruction is often wellnigh impossible. In the consideration of flat plates, it is very important to inspect films of all quadrants with a view to ruling out neurogenic, biliary, and renal calculi.

The first x-ray signs in an incipient case of ileus of mechanical origin are the presence of trapped gas and what is termed the "hairpin turn" (Fig. 1). A collection of gas in a dilated loop of the small bowel which, on successive films at hourly intervals, appears in the same loop, with or without further accumulation of gas in proximal loops, is, in our opinion, evidence of an oncoming ileus (Fig. 2). Furthermore, a dilated "hairpin turn" in the small bowel is the beginning of the so-called "step-ladder appearance" of massed superimposed loops of small intestines, and in its presence one must suspect a developing ileus (Fig. 3). These two findings have held true to this time and are to be viewed as definite signposts or red lights of warning. At this stage we do not know as yet whether we are dealing with partial or incomplete obstruction; such cases should be x-rayed at hourly



Fig. 1.

Fig. 1. Observe distention of gas in isolated small intestinal loops.



Fig. 2.

Fig. 2. Note "hairpin turn" and accumulation of gas in isolated loops at re-examination two hours later.



Fig. 3.

Fig. 3. Typical appearance of ileus: "step-ladder appearance," super-imposed dilated loops, marked valvulae conniventes, and "hairpin turn" all indicate mechanical obstruction.



Fig. 4.

Fig. 4. Note that in morphinization of bowel the distribution of intestinal gas simulates the pattern observed in intestinal obstruction. Presence of gas in ileum and colon aids in excluding diagnosis of intestinal obstruction.

intervals over a period of from six to seven hours, and if the accumulated gas does not

pass onward into the large intestine the diagnosis of partial ileus can be made with



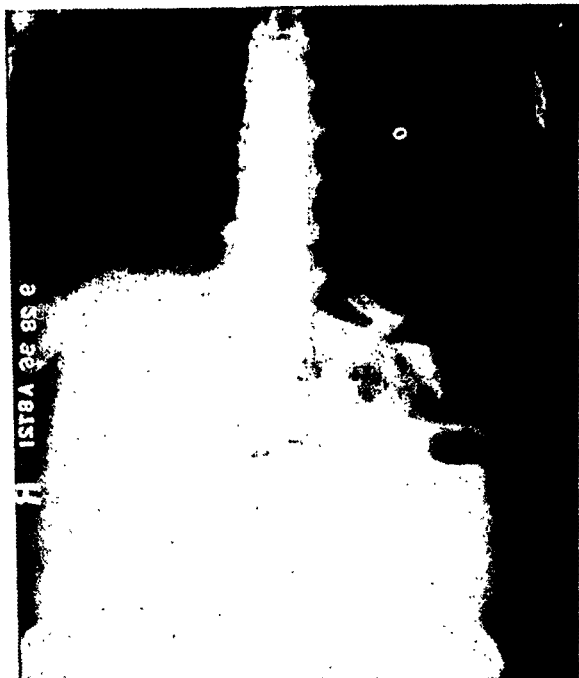


Fig. 5.



Fig. 6.

Fig. 5. Observe multiple fluid levels in upright position—a late sign of ileus.

Fig. 6. Subhepatic abscess. Note marked gastric distention and absence of intestinal dilatation. A radiopaque shadow in subhepatic area. These findings are strongly suggestive of a subhepatic collection of pus or fluid.

a fair degree of accuracy. It is inadvisable in such cases to wait for the development of a typical "step-ladder appearance."

The significance of intestinal gas within both the small intestines and colon is as follows: If the colon is dilated from rectum to cecum and there is to all intents and purposes only a little air in the small bowel, then small intestinal obstruction can be excluded, and with the exception of rectal obstruction, colonic obstruction also.

Tremendous dilatation of the colon or part of it associated with fluid levels in the absence of small intestinal gas is *per se* indicative of large intestinal obstruction. The differentiation of large and small bowel is not always simple; the presence of haustrations identifies the large bowel. In the absence of this distinguishing feature one should keep in mind the central lateral distribution of the colon when viewed in the postero-anterior roentgenogram.

A consideration of the physiology of the ileocecal valve and sphincter enables one to

correlate the above findings. According to Alvarez (1), the ileocecal sphincter acts as a barrier to most of the movements and contents of the ileum. By the folding of the muscle layers, contractions are led into a blind pocket where they are lost. Luciani (6) claims that peristalsis in the small bowel is not a continuation of that in the colon. The cecum, therefore, is a reservoir due to low irritability. The anemias of ileocecal lesions (tuberculosis, malignancy, and granuloma) are due to patency of the ileocecal valve, with rapid emptying of the contents of the ileum into the cecum resulting in faulty absorption. Regurgitation of bacteria, lodging normally in the cecum, into the ileum, produces fever, infection, and diarrhea. Thus, the ileocecal valve facilitates the diagnosis of ileus through its normal function as a sentinel between the small and large bowels. It is of interest to note that obstruction in the sigmoid may yield marked cecal distention and in some cases even cecal gangrene. As indicated by Case (2),



Fig. 7.

Fig. 7. Adynamic ileus. Differentiation from mechanical obstruction impossible but coils are often wider than in true mechanical obstruction.



Fig. 8.

Fig. 8. Mechanical intestinal obstruction. Segmented distribution of intestinal loops limited to upper abdomen and collapse of bowel distal to obstruction.

this curious finding is due to reversed peristalsis, predominant in the right colon, which may become exaggerated when originating in a tonic contraction ring in the sigmoid. Thus the cecum is caught between Scylla and Charybdis, suffering consequences even though far removed from the actual obstruction. The ileocecal sphincter is subject to the gastro-ileac reflex and contracts on stimulation of the pyloric sphincter. Distention of the stomach, duodenum, and ileum are accompanied by the same phenomenon, accounting partly for the absence of colonic gas in small bowel ileus (Henrichsen and Ivy, 5).

Morphine produces a general atonicity of the intestinal tract so that the effects of morphine may be manifested by large accumulations of gas both in the colon and small bowel. This gaseous distribution enables one to differentiate morphinization from ileus even in the presence of a pseudo-step-ladder appearance (Fig. 4).

Fluid levels in the obstructed bowel are comparatively late signs of obstruction

and are due to intestinal hypersecretion (Fig. 5). The higher the site of obstruction the greater the amount of fluid present. Morton and Sullivan (7) have studied the amounts of fluid secreted in obstructed loops of duodenum, which are vastly larger than in the ileum, with a consequent greater degree of distention in high obstruction. One of the causes of this discrepancy is the proximity of the duodenum to the gastric, pancreatic, and hepatic sources of secretion. Thus, marked distention of loops of small bowel points to a high obstruction. Increased fluid content means increased intra-enteric pressure and results in a higher mortality rate when the ileus is high. The work of Dragstedt, Lang, and Millet (4), on the variation of the intramural blood supply in various segments of the bowel, accounts for the ease of compressibility of duodenal blood vessels as compared to colonic vessels, lending a physiologic basis for the well-known earlier distress in small bowel obstruction.

The massing of dilated coils in the typi-



Fig. 9.

Fig. 9. Observe marked distention of bladder displacing large bowel upward. Patient's symptoms due to large bowel obstruction and urinary retention.



Fig. 9-A.

Fig. 9-A. Same case shown in Figure 9. Opaque enema reveals a volvulus at the hepatic flexure. Ascending colon and cecum are involved in the bowel torsion.

cal step-ladder is also a late sign of obstruction (Fig. 6). The presence of striations in the mucosa indicates jejunal obstruction, while the ileum is relatively free of valvulae conniventes. Duodenal or jejunal obstruction due to subhepatic collections is typified by marked distention of proximal small intestinal loops and gastric dilatation. We were thus able to diagnose a subhepatic abscess following cholecystectomy, producing an acute abdomen (Fig. 7).

The differentiation of adynamic ileus, peritonitis, and mechanical obstruction may be impossible by roentgenography alone (Fig. 8). However, in cases in which the intestinal distention is segmented and occupies only one quadrant of the abdomen, a mechanical obstruction may be inferred since the bowel distal to the site of obstruction is collapsed. Dynamic ileus is diffuse and generalized and usually presents marked bowel dilatation. Peritonitis, which is secondary to a ruptured viscus, may be diagnosed by finding subdiaphragmatic collections of gas.

Carcinomatosis has been diagnosed roentgenologically by observing x-ray features of obstruction plus a generalized haze throughout the abdomen, coupled with fading or complete blotting out of the ilio-psoas lines. A generalized haze without abnormal intestinal loops is often due to ascites or large collections of intraperitoneal blood, such as traumatic lacerations of the liver and spleen.

It is self-evident that enemas administered prior to roentgen-ray examination may produce fluid levels which may be falsely interpreted. It is, therefore, advisable to avoid use of enemas prior to routine survey film examination or to siphon off as much of the enema as possible so as to avoid the above diagnostic pitfall. While the roentgenologist may venture an opinion as to whether the obstruction is high or low, it is most often impossible to state categorically in what quadrant of the abdomen the obstruction is situated. It is helpful to remember that the majority of small intestinal obstructions are in the lower right quadrant.

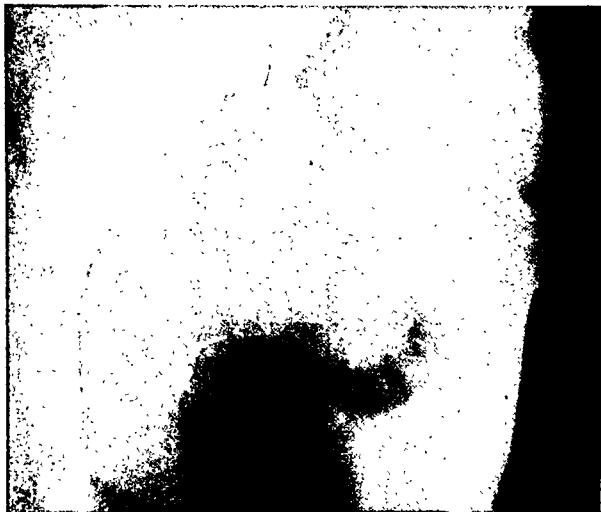


Fig. 10.

Fig. 10. Illustrates the importance of a low film in obstruction due to incarcerated femoral hernia in obese individuals.

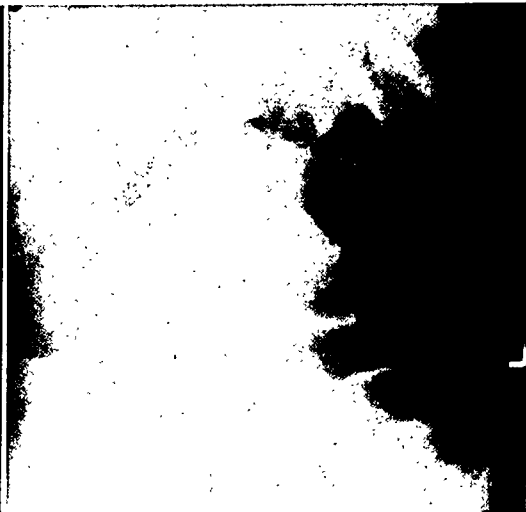


Fig. 11.

Fig. 11. Intussusception. Note the intussusceptum into the intussusciptens.

Another important consideration that alters the x-ray picture of obstruction is the frequent use of the Wangenstein suction apparatus. This decompresses the intestinal tract and often causes a disappearance of the step-ladder pattern though not of the obstruction, leading to an erroneous x-ray diagnosis and a false sense of security on the part of the surgeon. It must be stressed again that isolated loops of the distended small bowel spell obstruction and indicate surgical intervention.

Mesenteric thrombosis is usually characterized by a "step-ladder appearance" usually limited to a few coils, which are only moderately distended. Mesenteric tumors usually produce partial obstruction as well as displacement of adjacent loops of bowel. The loops of bowel usually have a feathery ribbon-like appearance which fades out away from the tumor or cyst.

Isolated bands from epiploic appendices constricting the bowel may give false shadows simulating cysts. Again survey films help to exclude mechanical intestinal dilatation due to huge bladder dilatation such as is seen in tabes and neurogenic bladders. After evacuation of the bladder one should search for organic causes of

obstruction such as volvulus. A case of this type is illustrated (Fig. 9).

Patients who have had previous gastrojejunostomies may present considerable gas in the jejunum, even in the absence of ileus, in the presence of functional nausea and vomiting. However, fluid levels are absent in these cases.

The simple expedient of including the femoral region in the survey film may reveal incarcerated femoral or inguinal hernias. This procedure is of value in obese individuals in cases in which such hernial sacs may be missed by the clinician (Fig. 10).

In all suspected cases of ileus, we routinely take three views, anteroposterior, postero-anterior, and upright. The anteroposterior view is usually most valuable in differentiating the large from the small bowel, possibly because of the superior films obtained in the supine position, since these sick patients are not always able to co-operate when lying prone.

It is still a speculation as to what the origin of the gas and fluid is in the ileus. Swallowing air during vomiting, fermentation, and putrefaction are undoubtedly all factors in gaseous distention, while intestinal hypersecretion accounts for intra-enteric fluid levels.

Evacuation of the bowel distal to the point of obstruction may occur with the onset of symptoms. A history of defecation with the onset of symptoms without subsequent stools does not rule out a mechanical ileus. Hyperperistalsis is an early feature in intestinal obstruction and differentiates it from dynamic ileus or peritonitis. As pointed out by Ochsner, abdominal distention is a relatively late sign in acute ileus of the small bowel, particularly in a high obstruction, and the diagnosis should be made before this becomes marked.

One of the most common causes of obstruction in infants is acute intussusception which may either be ileocecal, ileocolic, or colic in type. The cause of the first two types may be a mobile cecum or a lymphoid hyperplasia about the ileocecal valve. These lymphoid nodules may encircle the ileum and project for some distance into the cecum, favoring invagination of the small bowel. Chronic intussusception is most commonly due to intestinal polyps or Meckel's diverticulum. The roentgen picture of intussusception is that of any intestinal obstruction, except for the fact that in some cases the head of the intussusception may be actually visualized on the x-ray films (Fig. 11).

Pregnancy deserves special mention in the discussion of obstruction. Occasionally, the gravid uterus approaching full term may produce large intestinal obstruction by mechanical compression of the sigmoid or a redundant descending colon, with all the typical x-ray findings of intestinal obstruction. Such patients should have a barium enema administered in the knee-chest position, which will readily allow the flow of the opaque mixture into the proximal colon. If unrelieved by this procedure, the possibility of utero-sigmoidal or uterocecal bands angulating the gut should be considered.

It is important to remember that ileus may be co-existent with another non-surgical abdominal condition which may mask it, so that the former is brought to light only by a scout x-ray film and easily

may be overlooked by the clinician. One such case in this series was an actively bleeding duodenal ulcer associated with distention, which the x-ray revealed to be an obstruction (mesentery thrombosis). Another was a case with typical symptoms of cholelithiasis, which x-ray films proved to be a small intestinal obstruction (following an old cholecystostomy).

#### CONCLUSION

1. The diagnosis of acute intestinal obstruction can be made early by means of survey films of the abdomen.
2. The absence of "step-ladder appearance" does not rule out an ileus.
3. Patients should be examined in the prone, supine, and upright positions.
4. One should correlate the physical findings with the x-ray findings in attempting to differentiate dynamic ileus from mechanical obstruction.
5. In doubtful cases of obstruction, frequent x-ray examinations are essential for observing the progress of gas in the small intestine.
6. "Hairpin turns" and trapped gas in the small bowel are among the earliest signs of acute intestinal obstruction.

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# RADIOLOGY IN AMEBIASIS DIAGNOSIS<sup>1</sup>

By DR. GONZALO ESGUERRA-GÓMEZ,<sup>2</sup> Professor of Radiology at the National University of Colombia, Bogotá, Colombia, S. A.

THE Republic of Colombia being a tropical country, the amebiasis produced by *Endamæba histolytica* is extremely frequent. It may be said that there is amebiasis in every city in Colombia, but its infection index—which has been impossible to determine exactly owing to lack of accurate statistical data—varies according to the several climatic zones. Cities located at an altitude of 2,634 meters, such as Bogotá, show a high percentage of amebiasis not only because great numbers of its inhabitants go out of town to lower or warmer climates, but also because contamination has been demonstrated in patients who have never been out of town. But as compared with other cities, the number of amebic patients is much smaller at an altitude of 2,634 meters, with an almost constant annual temperature of about 14° C. The number is much higher in cities located at sea level, like Barranquilla and Santa Marta, where the mean temperature is 27° C., and it seems still higher in climates having an altitude of from 800 to 1,600 meters above sea level with a temperature varying between 18° and 23° C. The difference between the last two groups is not considered great and mostly varies according to the localities studied, where infestation is naturally variable. All those places are invaded by amebiasis and comparison can be properly established only with cities more than 1,800 meters above sea level, where it is much less frequent. It has been my privilege to practise my profession in the city of Bogotá, capital of the Colombian Republic, and taking into account the above mentioned points, I have been led to consider the grade of amebiasis propagation in lower climates, since the statistical

data which I have endeavored to collect demonstrate the enormous expansion of this infection among the inhabitants of Bogotá.

I refer to such data as the following: At the bacteriological laboratory of the Misericordia Hospital at Bogotá, which is exclusively devoted to children and where all patients are gratuitously cared for, it has been normal practice to make a coprologic examination for intestinal parasites in nearly all the patients. In 2,218 coprologic examinations, made between Jan. 1, 1936, and April 30, 1937, there were 173 patients with *Endamæba histolytica* cysts and 75 with vegetative forms of the same: that is, 248 cases of amebiasis in the patients examined. It may, therefore, be said that 11.18 per cent of the children who have come to the hospital were carriers of amebic germs.

At the laboratory of the San Juan de Dios Hospital, where the wards of the Faculty of Medicine are located, I also took information on 2,218 coprologic examinations carried out during the last months of 1936 and during 1937 up to June 15. I found 670 cases with amebic cysts and 151 with vegetative forms of the same. This means an infestation of 37.01 per cent. It must be pointed out that in the last named hospital a general examination is not carried out on every patient, the total number of whom is 1,400 per day, but only on those who are clinically suspected of having intestinal parasites.

At Professor Federico Lleras Acosta's private laboratory, 89 cases were found with amebic cysts or vegetative forms, in 500 examinations carried out during 1937 and the last months of 1936. The percentage is, therefore, 17.8. At another private laboratory, that of Professor Pedro J. Almanzar, there were 161 cases with amebic germs, in 1,604 coprologic ex-

<sup>1</sup> Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

<sup>2</sup> Delegate of the Republic of Colombia to the Fifth International Congress of Radiology.

aminations made from June 1, 1935, to May 30, 1937; that is, a percentage of 10.03. Attention must be drawn to the fact that to these last two laboratories go only individuals of intelligence and social standing who have been clinically suspected of an intestinal parasitism or who have undergone a complete examination and have especially asked for a coprologic examination, even if they are not suspected clinically. The last ones are, of course, much less frequent.

The total number of coprologic examinations mentioned amounts to 6,540, of which 1,319 showed amebic cysts or vegetative forms of the same; that is, 20.16 per cent positive examinations showing amebic germs.

The above statistical data reveal the frequency of amebiasis among the inhabitants of Bogotá, and as it is acknowledged that such disease is far more extensive at lower altitudes or in warmer climates, one cannot but speculate how frequent amebiasis is in the whole Colombian territory.

Now, all Colombian physicians are well aware of the frequency of amebiasis and hence their clinical knowledge of it is sufficiently sound to enable them to detect the disease in every case of an acute or chronic dysenteric symptomatology. At the same time, the protozoologists who deal with its microscopic examination have a very good practice, and, therefore, we must credit the results of their examinations. But two other important points must be taken into consideration: the first one is the well-known fact that a single isolated coprologic examination with a negative result for amebic germs does not imply the absence of such parasites. It is necessary to make at least three consecutive examinations within one month in order to be quite sure. The second point to be considered is the percentage of patients who are carriers of *Endamæba histolytica* without dysenteric phenomena.

Since the symptomatology of amebiasis is exceedingly variable, the clinical knowledge of physicians dealing often with such

disease, added to the data supplied by the laboratory, and the success obtained in several patients submitted to an antiamebic treatment (although the laboratory examinations were negative), are not altogether sufficient to enable one to detect all the patients who suffer digestive disorders due to an amebic infection.

The variable manifestations of amebiasis allow us to classify the disease into the following four groups: I. Amebiasis with dysenteric phenomena in acute period; II. Chronic amebiasis with recurrent dysenteric attacks; III. Chronic amebiasis with variable digestive disorders, without dysenteric phenomena: (a) with dysenteric antecedents, (b) without dysenteric antecedents; IV. Carriers of amebic germs without clinical symptoms.

The first two groups, the diagnoses of which are daily made from the clinical symptoms and laboratory test, are seldom sent in for a radiologic examination. Only a few dysenteric patients with recurrent attacks are thus examined between two consecutive periods, but as a general rule it is not customary to carry out a radiological examination on patients belonging to the first two groups above mentioned. On the other hand, very often patients who have no colitis symptoms come to x-ray laboratories with various digestive phenomena but mostly without suspecting amebiasis, and through a radiologic examination it has been possible to demonstrate the presence of such disease. The last group, the carriers of germs, are identified only at an x-ray laboratory by experiment, since a patient having no disorder does not consult either the radiologist or the digestive tract specialist.

It is, therefore, the third group which usually comes to the radiological laboratory. And since the clinical examination has not brought amebiasis to evidence and since as a rule the patient does not remember whether or not he has had dysentery at some remote time, it helps greatly to find radiologic signs that may help toward the diagnosis of amebiasis.

In my own private laboratory at the

Marly Clinic I have found, in a total of 11,067 patients examined to date, 124 cases of confirmed amebiasis and 13 cases of probable amebiasis. Out of the total number, approximately 50 per cent were examined for the digestive tract, but it may be said that for the first 5,000 patients examined from April, 1923, to March, 1931, I had not had enough practice to be able to direct my diagnosis toward amebiasis, as I find only three patients classified under that disease during that time. The remaining 134 patients are between the numbers 5,000 and 11,067, that is, between March, 1931, and May, 1937. Therefore, among those last patients, half of whom were examined for the digestive tract, there were approximately 4 per cent with amebiasis diagnosis.

I must point out that during the last ten years I have made a most complete radiological examination on every patient who has come in for disease of the digestive tract. This means that if a patient comes to me or is referred to me for a simple gastric, vesicular, or intestinal examination, I make a thoroughly complete investigation of all his digestive tract. In each patient I study the gall bladder by the oral Graham-Cole method, using a single dose of tetraiodide. I make the examination at the end of 14 hours, before the patient has had anything to eat, and again at 20 hours, after the patient has taken his usual daily lunch. Later on I study the stomach and duodenum. After 6, 12, 24, and sometimes after 36 and 48 hours, following the ingestion, I study the cecum and colon, and if it is necessary, I finish the examination with an opaque enema. I have described the technics followed in my examinations because with these complete studies there is greater probability of detecting any amebic lesion in patients whose symptoms may be, for instance, exclusively gastric.

In order to verify the radiologic studies made during recent years in civil practice, and considering that acute or chronic cases with recurrent and dysenteric phenomena did not reach my laboratory,

toward the end of last year I decided to make an experimental study on 25 patients, nearly all from the San Juan de Dios Hospital. The results thus obtained confirmed the previous knowledge thus far acquired.

#### SCIENTIFIC LITERATURE

Having established the importance of radiology in the investigation of amebiasis, it is astonishing to find so little scientific literature on the subject. In 1924 (1) and again in 1928 and 1934 (2, 3), J. J. Vallarino stated that the amebic ulcerations of the colon produce "repletion defects" which may be clearly seen on a roentgenographic film. He pointed out some irregularities in the outline of the intestinal parts affected, whose most frequent locations are, first, in the cecum, then the ascending colon, and lastly in the sigmoid. Having had an extensive practice for several years in Panama, he came to the conclusion that the abnormalities pointed out, although not pathognomonic, are useful in practically every case to confirm later on the existence of amebiasis.

E. Speder has studied the matter since 1917, and of his three publications with which I am acquainted (4, 5, and 6) the last one (6) is a résumé of his 19 years of observation during a practice of radiology in an absolute tropical region like Maroc. He brings out the fact that in old amebic patients a single examination at the laboratory and one without previous preparation, shows amebic germs in only 20 per cent of cases, and that repeated laboratory examinations hardly show it in from 40 to 60 per cent of cases. He holds, therefore, that the radiologic aspects, which in certain cases are characteristic of an amebic colon in from 60 to 70 per cent of cases, should be sufficiently convincing to the practising physician to cause him to repeat the microscopic investigations or to insist on a trial treatment. He classifies the aspects of the amebic colon into several groups, according to the age and the degree of the infection, to the degree and nature



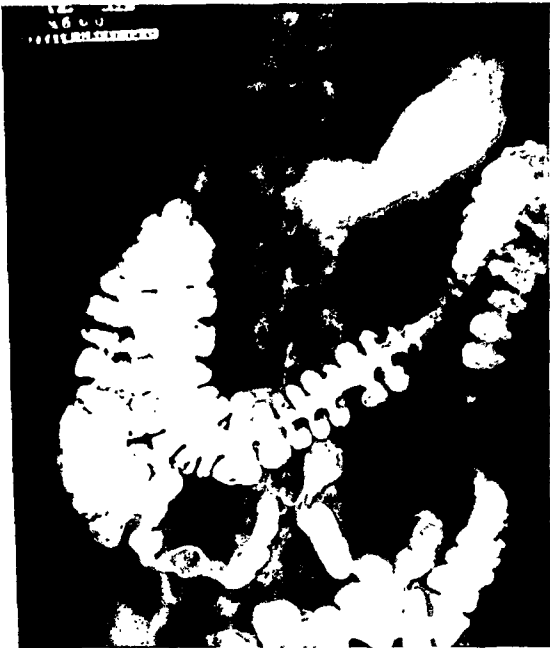


Fig. 1.

forms, and in all other chronic amebiasis cases there were found *E. histolytica* cysts.

SUMMARY OF SOME OBSERVATIONS

Case 9660. Amebiasis colitis with recurrent attacks. The patient had the last dysenteric crisis a year before examination. Since then he has been suffering from severe pain in the epigastric and hepato-vesicular regions, which passes away upon eating. On palpation at McBurney's point there is epigastric pain. Figure 1 was taken six hours after barium ingestion. Notice in it the six-hour gastric retention, colic hypersegmentation, irregular aspect of left part of transverse colon and of middle third of descending colon, the lower location of transverse colon, especially of its right half—with normal location of stomach—and the presence of fore part of barium meal at rectum after six hours. Twelve hours later there was ileal retention, and 24 hours later the whole opaque meal remained in the large bowel. Normal gall bladder

<i>Endamæba coli</i> .....	1
<i>E. histolytica</i> cysts.....	9
Vegetative forms of <i>E. histolytica</i> .....	10

In the six acute cases, in the two in



Fig. 1-A.

which the acute stage had just passed, as well as in the chronic case with dysenteric phenomena, there were found vegetative

After examination there were amebic cysts present in the stools. Treatment: emetine, carbarsone, and stovarsol. The

patient recovered with this treatment and has not returned. (See also Fig. 1-A.)

Case 10382. Removal of appendix some years before. Six months before examination patient had amebic dysentery from

six hours' ingestion; Figs. 3 and 4 after 12 and 24 hours' ingestion, and Figs. 5 and 6 with opaque enema). Notice gastric retention at six hours and ileal retention at 12 hours, the small diverticula of ileum, the un-



Fig. 2.



Fig. 3.

which he recovered completely with treatment. Consulted physician because of very strong abdominal cramps located in

equal hypersegmentation of transverse colon with spasmodic narrowing at its middle third, the small "saw-toothed" contours

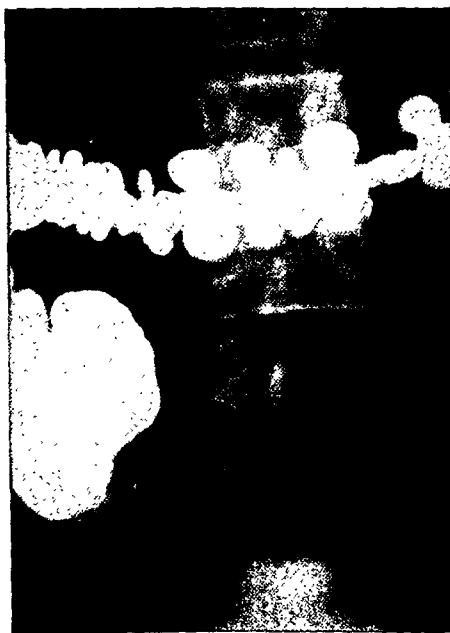


Fig. 4.

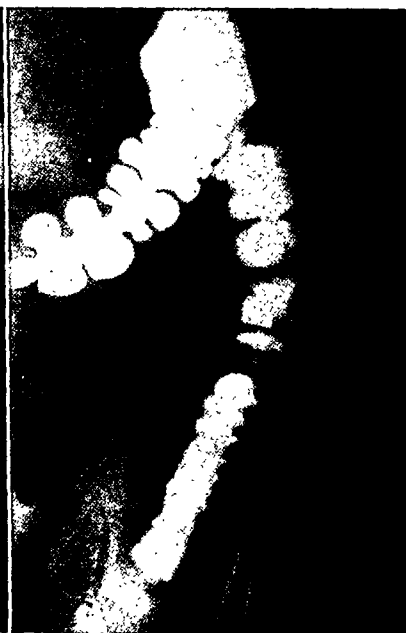


Fig. 5.

hepato-vesicular region. No colitis phenomena nor any amebic cysts found in the stools at time of examination (Fig. 2 after

of the descending colon and its narrowing after enema injection, and the small quantities of barium distributed all along the

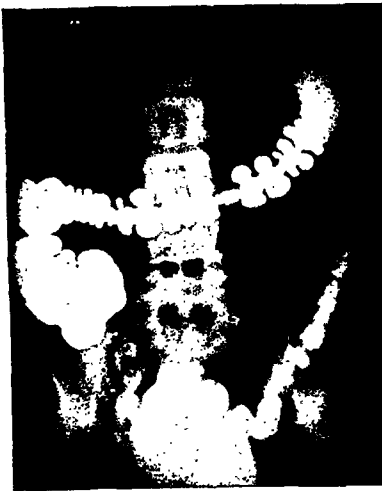


Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 12.



Fig. 13.

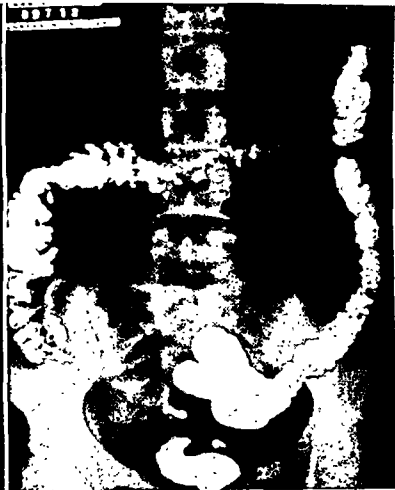


Fig. 14.



Fig. 15.



Fig. 16.



Fig. 17.

transverse and descending colon apparent at the six- and 24-hour examinations. The gall bladder was not visible by oral cholecystography. Bile examination after duodenal intubation did not reveal any abnormality. Presence of amebic cysts in stools after one month; increase of such cysts at the beginning of anti-amebic treatment. Cramps disappeared after two months' treatment.

Case 10363. Patient suffered for nine months from strong epigastric cramps, which started during pregnancy. Miscarriage at six months and persistency of cramps after it. Old antecedents of colitis with mucus and painful phenomena but without diarrhea. The gall bladder was normal. Figure 7 shows films taken 12 and 24 hours after ingestion, and Figures 8 and 9 were taken at the same moment but with additional opaque enema. There was also gastric retention at six hours. Notice increase of haustral markings in cecum, ascending and transverse colon (very unequally distributed in the former), delay in colic transit in spite of hypersegmentation, narrowing of descending colon after enema, and "saw-toothed" contours of part of descending colon. Patient improved with anti-amebic treatment and has been well up to the present time.

Case 10264. This patient suffered for

three months from strong epigastric cramps; pain all over right part of abdomen; had fever up to  $38^{\circ}$  C. two or three nights per week. There were very remote amebic antecedents. (Figure 10 was taken six hours after ingestion and Figures 11 and 12 were taken 12 and 24 hours, respectively, after barium meal and with opaque enema at the same time.) Note gastric retention at six hours; the colitis aspect in this film of transverse colon, with irregularity of contours, narrowing and shortening; the small "saw-toothed" contours of cecum and descending colon with narrowing of latter; unequal distribution of haustral markings in transverse colon seen at last examination, and flattening of hepatic flexure of colon due to compression by very large liver. Positive coprologic examination for amebic cysts; increased number of white cells and polynucleosis, with no eosinophiles. Normal gall bladder. Diagnosis: hepatic abscess of amebic origin at first, with amebic lesions at cecum and colon. The patient recovered under anti-amebic treatment.

Case 10486. Appendix had been removed; amebic colitis antecedents; two to three soft stools per day; epigastric pain and pain over the transverse colon. (Figure 13, taken 12 and 24 hours after



Fig. 18.



Fig. 19.

repeated barium ingestion and also with opaque enema.) Barium after 24 hours in the transverse colon. Gastric retention at

with increased narrowing of left part. Several coprologic examinations made after-



Fig. 19-A.

six hours. Normal gall bladder. Notice narrowing and shortening of transverse colon and small "saw-toothed" contours

ward confirmed the presence of amebic cysts. Extended treatment with Ravaut paste, potassium iodide enemas, and eme-

tine. Improved but not completely recovered.

Case 9713. Without dysenteric phenomena or amebic antecedents. Pain all along the colon and over the appendix; anemia. (Figures 14 and 15 after 12 hours of barium ingestion and also with opaque enema.) Normal gall bladder with a stone. Evacuation of barium at 18 hours. Note the irregular picture of cecum, ascending and transverse colon, with small "saw-toothed" contours, with noticeable deformities of cecum and the presence of very small quantities of barium in left part of transverse colon. Also notice aspect of descending colon and its "saw-toothed" contour at its inferior half. Amebic cysts, ankylostoma, trichocephalus, and *Ascaris* eggs in stool. Greatly improved during last year with anti-amebic and parasiticide treatment.

Case 8741. Six gall-bladder colics. Dysenteric antecedents 12 years before. Negative coprologic examination. Gall bladder not visible after oral cholecystography. Bile examination after duodenal intubation showed cholecystitis without stones. (Figures 16 and 17, the first one taken at six hours after barium ingestion and the second one 24 hours later and also with opaque enema.) Notice cecal deformations due to post-operative adhesions. There was gastric retention after six hours; owing to the ingestion there was narrowing of transverse colon, hypersegmentation and "saw-toothed" contour of its middle third, and after enema there was appreciable distention of transverse colon with persistence of hypersegmentation at its lower edge. Medical treatment for cholecystitis and colitis with little improvement after four months.

Case 8704. Clinical and roentgenologic diagnosis of chronic appendicitis, confirmed by operation. There were found membranes on cecum and ascending colon and an obviously inflammatory process of appendix. Patient was well for six months after which time he had strong pain along the cecum and right colon. Figure 18 (roentgenogram made before operation)

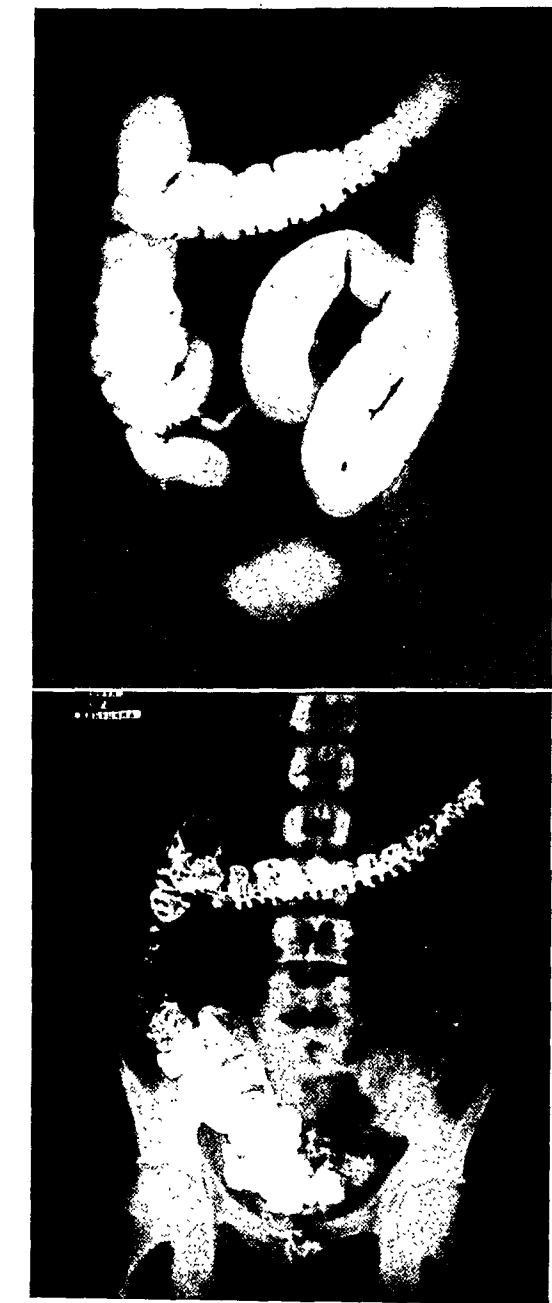


Fig. 20 (above). Fig. 21 (below).

showed signs of colitis, and although there were no dysenteric antecedents nor amebic cysts in the stools, he was submitted to treatment and has improved. Gall bladder was normal.

Cases 6020 and 10082. The first examination, shown in Figures 19 and 19-A, was made in September, 1932, by barium ingestion, and Figures 20 and 21, taken

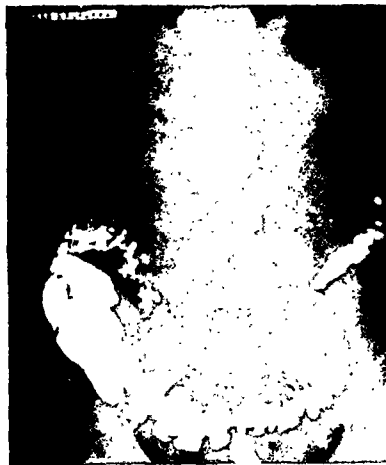


Fig. 22.



Fig. 23.



Fig. 24.

with "diagnotorine" enema and imbibition of mucosa, were made in October, 1936. Without dysenteric antecedents. Patient suffered from epigastric cramps, lasting for one or two hours. At first ex-

amination, attention was called to unequal hypersegmentation of colon with narrowing and small "saw-toothed" contours in some sites. Had a very incomplete anti-amebic treatment until second examination. At this time the examination by ingestion gave identical results; with enema it showed narrowing and shortening of colon with numerous small segmentations; folds of mucosa were quite normal in descending colon and abnormal impregnation of rectum and terminal part of sigmoid was confirmed. Proctoscopic examination showed small ulcerations in those sites. Amebic cysts in stools. Cramps disappeared with extended anti-amebic treatment.

Case 10071. Very old dysenteric antecedents. No amebic cysts in stools, nor ulcerations at proctoscopic examination. Improved with treatment. (Figures 22, 23, and 24 taken after ingestion as well as with "diagnotorine" enema and mucosa impregnation.) Notice ptosis of transverse colon, dilatation of cecum and of transverse colon with enema; unequal hypersegmentation without dilatation of transverse colon by ingestion, and the small "saw-toothed" contours of descending colon and cecum. (See also Fig. 23-A.)

*First Experimental Case, San Juan de Dios Hospital (M. J. H.).*—Acute dysentery with amebic cysts in stools. Very ulcerated mucosa and pseudo-membranes at proctoscopic examination. It was only



Fig. 23-A.



Fig. 25.



Fig. 26.

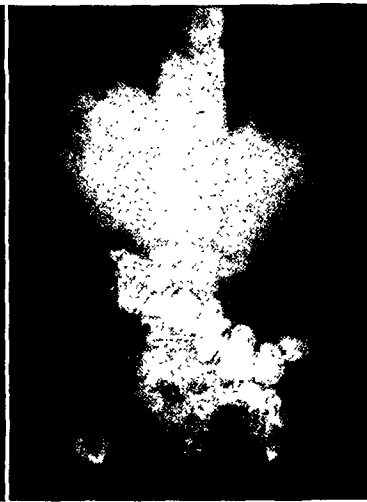


Fig. 27.

possible to reach the long sigmoid with the "diagnotorine" enema. See Figures 25 and 25-A, from which will be clearly appreciated the small extensibility of walls of intestinal segment examined, hypertrophy of mucosa folds, and "saw-toothed" contours, especially noticeable at terminal part of sigmoid.

*Fourth Experimental Case (R. B.).*—Dysentery just after acute period. Clinical signs of hepatic abscess. Isolated round ulcerations covered with a gray coating and located preferentially on rectum valves. Congested mucosa around ulcerations. Numerous amebic cysts in stools. The rectal segment most affected is seen with opaque enema (Fig. 26), rather dilated with gases, without other peculiar radiologic appearance. Sigmoid contours are regular except at its terminal part where they become "saw-toothed." Flattening of right flexure of colon due to compression by liver. In Figure 27 is shown the abnormal impregnation of mucosa at terminal part of sigmoid.

*Fifth Experimental Case (J. C.).*—Acute dysentery. Numerous *E. histolytica* cysts. Numerous bleeding ulcerations at rectal region with mucosal edema around them. Figure 28, taken with opaque enema, does not show anything special at rectum. Notice aspect of transverse colon and part of descending colon, where the appearance is that common to all ulcerative colitis.

*Sixth Experimental Case (S. A.).*—Note Figure 29 (with "diagnotorine" enema) and Figures 30 and 30-A after a stool. Amebic cysts in the stool: bloodless diarrhea. No ulcerations observed at proctoscopic examination. Notice contours of terminal portion of sigmoid in both views, as well as mucosal impregnation of that intestinal segment seen in second view.



Fig. 25-A.





Fig. 28.



Fig. 29.



Fig. 30.

*Seventh Experimental Case (A. S.).—*Acute dysentery; numerous amebic cysts. Proctoscopic examination showed sound mucosa at end of sigmoid and deep bleeding ulcerations at rectum as well as pseudomembranes and mucosal edema at anterior

tion at its top part. Wall induration, as well as narrowing and "saw-toothed" contours at the sigmoid zone near the middle line are observed (Fig. 31-A).

*Eighth Experimental Case (S. A.).—**E. histolytica* cysts, no digestive phenomena



Fig. 30-A.

wall of rectum. In Figure 31, taken with opaque enema, no irregularities of contour are observed at rectum; gaseous dilata-

and normal proctoscopic aspect. In Figure 32 are clearly seen "saw-toothed" contours and narrowing of descending colon at union



Fig. 31.



Fig. 32.



Fig. 33.

of middle third with superior third. Figure 32-A shows flattening of right colon flexure due to compression by liver.

*Ninth Experimental Case (P. E.).*—Acute dysentery; amebic cysts; numerous ulcerations seen at proctoscopic examination. In Figure 33 is noticeable only the small extensibility of left terminal part of colon

and an abnormal mucosal impregnation of rectum at ulceration and edema sites.

*Thirteenth Experimental Case (A. F.).*—Recurrent dysentery; amebic cysts; sigmoid and rectum ulcerations (Fig. 34, with opaque enema). Notice regularity of rectum and of beginning of sigmoid, and great length of the latter. Slight “saw-toothed” contours of part of sigmoid. In Figure 35—by ingestion—barium meal is seen at stomach below transverse colon. Notice “saw-toothed” contours, narrowing and unequal segmentation of that sigmoid segment below the transverse colon.

*Fifteenth Experimental Case (L. C.).*—Dysenteric phenomena; only *B. coli* cysts



Fig. 31-A.



Fig. 32-A.



Fig. 34.

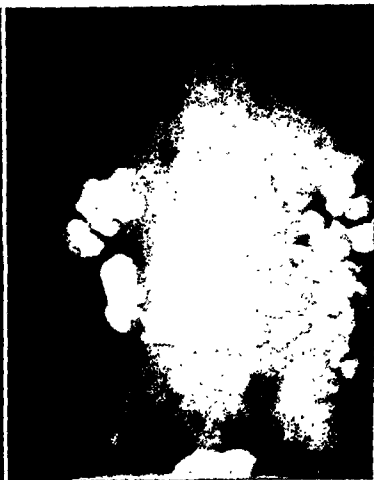


Fig. 35.



Fig. 36.

found; normal mucosa seen at proctoscopic examination (Fig. 36, with opaque enema). Note the difference of aspect as compared with other cases. In Figure 37 we observe mucosal impregnation while aerocolia is present.

*Seventeenth Experimental Case (R. A.).*—Dysentery after acute stage; ulcerations shown by proctoscopic examination. In roentgenographic film (Fig. 38, with opaque enema) one can observe only a very long and hypersegmented sigmoid. Note in Figure 39 impregnation of mucosa at terminal part of ulcerated bowel.

#### SUMMARY AND CONCLUSIONS

1. *Endamæba histolytica* amebiasis is very frequent in the whole territory of the Republic of Colombia. Such frequency is less in cold climates at high altitudes, like Bogotá, the capital of the Republic. However, the extension of amebiasis among the inhabitants of Bogotá is demonstrated, among other things, by the fact that in 6,540 coprologic examinations carried out at various laboratories in town, there were found 1,319 cases with *Endamæba histolytica*—that is, 20.16 per cent of the patients examined.

2. Although Colombian physicians and microscopists have a good practice in the diagnosis of amebiasis, the variableness of the clinical aspects of the disease and the lack of confidence in isolated laboratory

examinations explain why many cases may pass by unnoticed.

3. Chronic amebiasis patients without dysenteric phenomena and with an exceedingly variable symptomatology form a group of patients difficult to diagnose clinically and in whose examination x-rays are most useful. Neither acute amebic patients nor those with recurrent dysenteric attacks pass unnoticed by the clinic physician and for that reason such patients are seldom sent in for a radiologic examination. As regards carriers of germs, without clinical symptoms, their radiological examination is necessarily exceptional.

4. In 5,067 patients radiologically examined since 1931, a diagnosis of amebiasis has been made in 4 per cent, afterward confirmed, among those suffering from digestive troubles. The symptomatology of these patients was quite variable and none of them had any colitis signs when examined.

5. By means of a complete radiologic examination of the digestive tract, I several times found some signs that allowed me afterward to confirm the original amebiasis diagnosis.

6. Experimentation on 25 patients with radiologic, proctoscopic, and laboratory studies allowed me to observe in amebic patients with dysenteric phenomena in acute stage or soon after this, findings

identical to those from chronic amebiasis patients.

7. There is very little scientific literature available on amebiasis, taking into account that such disease is so frequent in tropical countries and that x-rays may be very useful for its diagnosis.

8. I often found an appreciable gastric retention in amebic patients, at the end of six hours. In some patients suffering from gall-bladder colics, clinically determined, the gall bladder was not visible by Graham-Cole's method, the examination of bile was normal, and colics disappeared with the anti-amebic treatment. Very often I found the liver volume increased and causing a deformation of the colon right-angle, and in the duodenum and ileum I could not find any peculiarity.

9. Generally the cecum-colon transit was accelerated during the first few hours but later on it was common to observe a retarded intestinal evacuation.

10. One of the most important points observed in the studies made by barium ingestion was the increased number of haustral markings of the colon, especially in the transverse colon, with variable frequency and intensity, and its corresponding narrowing.

11. In some cases there were, in the colon, unequal distribution of the barium meal, diminution or absence of haustral markings, atony of colon walls, and aerocolia.

12. The group of radiologic findings most frequently found was formed by a segmentary induration of the cecum or colon walls and the presence of "saw-tooth" contours. Such a radiologic aspect or picture, located at isolated intestinal segments, is characteristic of the presence of ulcerations in those sites.

13. The study of mucosa by impregnation does not seem of any practical utility in amebiasis diagnosis.

14. Generally the same radiologic data of chronic cases were observed in acute amebiasis, although not in cases at the beginning stage.

15. The descending colon, the colon



Fig. 37 (above). Fig. 38 (below).

segments adjacent to the hepatic and splenic flexures, the sigmoid, and lastly the other colon segments are the sites radiologically indicated where the disease is located. As a rule, the lesions of the rectum, without impregnation of the mucosa, pass unnoticed in the examinations by ingestion and enema.

16. The above observations, made in chronic amebiasis patients and in those

experimentally studied, corroborate the aforesaid conclusions.

*It is my opinion that the complete radiologic investigation of the digestive tract, carried out in patients in the city of Bogotá when the above-described radiologic signs are found, allows the physician to focus his study on amebiasis. He thus obtains a valuable help in the diagnosis and treatment of that disease.*

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# ROENTGEN AND LIGHT THERAPY OF INTESTINAL AND PERITONEAL TUBERCULOSIS<sup>1</sup>

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**R**OENTGEN and light irradiation have been applied to intestinal and peritoneal tuberculosis with results sufficiently favorable to warrant their more frequent trial. In this paper will be discussed briefly their effects on animal and human tissue, the indications and technic of usage in accord with the pathology, the clinical applications, and comparative clinical results.

*Effects of X-ray on Body Tissue.*—The susceptibility of cells to x-ray varies according to a specific range of sensitiveness of each histologic variety. Certain kinds are injured or destroyed by small doses of x-ray, while others resist and tolerate large doses. With excessive dosage even the least radiosensitive varieties of cells may be injured or destroyed.

Cells most radiosensitive (1) are: lymphoid cells or lymphocytes, present in spleen, lymph nodes, intestinal lymph follicles, circulating blood, bone marrow, thymus, tonsil, etc.; polymorphonuclear leukocytes and eosinophiles in blood or tissues; epithelial cells; endothelial cells of blood vessels, pleura, and peritoneum; and connective tissue; muscle, bone, fat, and nerve cells.

The most susceptible cells are those which, from a metabolic standpoint, are younger and mitotically more active; the cell age is less important than the specific vulnerability of different cell varieties, in determining reaction to x-ray exposure.

*Effect of X-ray Exposure on Intra-abdominal Lymph Glands.*—Lymphoid tissue in the intestinal wall and in intra-abdominal and mesenteric glands responds biologically to x-ray irradiation in the same manner as lymphoid cells elsewhere in the body. Exposure of the entire animal body shows that, depending on the degree of

dosage and the interval between their irradiation and death, there is marked destruction of lymphocytes. Lymphocytic disintegration may take place within 15 minutes after exposure. As lymphoid follicles disappear stroma becomes more prominent. The lymph glands atrophy and are progressively reduced in volume. Phagocytic reticular cells ingest nuclear chromatin of destroyed cells which finally undergoes intracellular digestion. Some regeneration of lymphoid tissue occurs after from seven days to three weeks.

*Effect of excessive radiation on intestinal mucous membrane* varies for different parts, the mucosa of the small intestine being more sensitive than that of the colonic mucosa. The duodenal and jejunal mucosa are the most sensitive portions of the alimentary tract and may be irritated with x-ray dosage insufficient to produce erythema of overlying skin. Within a few hours after a therapeutic dose is given to the upper half of the abdomen, digestive disturbances characterized by anorexia, nausea, and vomiting may occur, and after several days, diarrhea.

Warren and Whipple (2) have shown in experimental work that the mucosa of the small intestine is highly susceptible to hard and short wave roentgen rays and that an overdose may produce intestinal ulceration.

In animals exposed to excessive doses there is mucinous degeneration of intestinal epithelium, hyperemia, and edema of the mucosa and submucosa, and there may be desquamation of epithelium. If the reaction is not too severe, the mucosal defect may be repaired by epithelial regeneration or connective tissue replacement.

*X-ray Therapy of Tuberculous Lesions.*—The dosage for chronic inflammatory lesions, as tuberculous intestinal and peritoneal disease, must be larger than that

<sup>1</sup> Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

used for acute inflammatory lesions. The most effective dose varies between 50 and 80 per cent of the limit of tolerance of the skin. In the skilled hands of an experienced radiologist, possessing modern equipment, capable of administering accurate dosage, deleterious effects upon the skin such as epithelial hyperplasia and malignant transformation due to chronic irritation, may be avoided. Dosage distinctly smaller than the maximal dose required in the treatment of tumors is recommended. For cure or maximal benefit it is important that irradiation be repeated a number of times at from three- to four-week intervals. Smaller doses may be repeated at shorter intervals. With repeated periodic exposure of the affected region, combined with exposure of the whole body to gradually increasing doses of ultra-violet rays, slow but complete resolution of the chronic inflammatory process may be obtained.

*Mode of action* of radiotherapy on chronic tuberculous lesions depends on two factors, the degree of leukocytic infiltration and the proportion of connective tissue and of degenerative products such as caseation and calcium. These factors govern also the time required to bring the lesions under control.

The rays do not exert a direct bactericidal action. Theoretically, the deleterious effects on the tubercle bacilli are brought about by a change in soil or body tissue. The organisms are believed by some to be destroyed by autolytic enzymes released from dying cells. It seems likely that destruction of infiltrating leukocytes liberates the antibodies and other protective substances within the cells, making these substances available for defense purposes. Perhaps the roentgen ray excites the epithelioid cells in their phagocytic action on the tubercle bacillus or possibly it produces a general effect through autotuberculinization. Of interest is the theory that defense substances of the reticulo-endothelial system contained in skin are sent into the circulation to make healing permanent.

In the application of heliotherapy and roentgen irradiation to intestinal and peri-

toneal tuberculosis, the nature of the pathology in the intestine and peritoneum (exudative or proliferative) must be defined and correlated with that of the pulmonary tuberculosis, if the latter exists, before therapy can be offered.

*Ulcerative intestinal tuberculosis* is found in from 50 to 80 per cent of autopsies on persons dying of pulmonary tuberculosis. This establishes intestinal tuberculosis as the most frequent complication of phthisis.

Bacmeister, in 1921, was among the first to use x-ray therapy for this disease with favorable result. At Trudeau Sanatorium (3) the therapy was used alone and in combination with ultra-violet light, often with most gratifying results. The average dosage given in roentgenologic treatment over the abdomen was 5 milliamperere-minutes (90 kilovolts, 2.5 to 3 milliamperes, filtered through 3 mm. of aluminum, tube distance 35 cm.). The authors found the "intestines very susceptible to roentgen rays and that reactions of some intensity with recurrence or increase of all intestinal symptoms could easily be brought about."

In the technic employed by Rother (4), an individual dose never exceeding one-third of a skin dose (200 r) is given over an area of the abdomen from 10 to 15 cm. in size through a compression tube at a distance of 30 cm., through a filter of 0.5 mm. of zinc or copper at a tension of 180 kv. Weekly or greater interval exposures are recommended, until each area has had an exposure of 600 r.

In many cases, roentgen-ray treatment has been combined with ultra-violet therapy, in cases in which light radiation alone did not give the desired results. However, caution is advised, in combining the therapy, against the danger of a burn from an otherwise safe dose of roentgen rays and also against the possible cumulative effect of roentgen rays. An overdose may produce intestinal ulceration, and deaths have been reported from severe intoxication following roentgen-ray treatment, due to ulcerative enteritis. It is generally agreed that great caution is required in treating the ulcerative tuberculous intestine char-

acterized by caseation. In cases in which it is characterized by granulation tissue, that is, tending toward the proliferative or hyperplastic, as apart from the exudative or caseating form, it is believed the roentgen rays can cause general regression and fibrous transformation. In cases tending toward caseation, x-rays may precipitate breakdown.

*Peritoneal tuberculosis* is usually secondary to and takes place by direct extension from a tuberculous lesion in the intestine, caseating abdominal retroperitoneal or pelvic lymph glands or organs in the pelvis. It may also occur by metastasis from a remote primary focus in the lung or cervical lymph glands. Postmortem records show the lung involved in over 90 per cent of cases.

In treating this form of tuberculosis x-rays were first successfully used in 1899 by Bircher, Ausset, and Bedard. Since that time much has been reported in medical literature. Great benefit apparently can be obtained from x-ray irradiation of this condition. Results are not so favorable when there is serious co-existing involvement of the lungs or other regions.

In the *fresh ascitic or exudative* form, particularly good results have been obtained with x-ray therapy. The *plastic type with extensive adhesions and omental tumors* is not easily influenced, although ultimately great benefit has often been obtained in these cases also. In the *caseous type* results are not so good despite treatment continued over a long period.

In the presence of abdominal distention, ascitic fluid is first drained from the peritoneal cavity and the abdomen then irradiated (5). Both low voltage x-rays with aluminum and high voltage rays with copper filtration have given good results. Our technic, following that of Knox and Levitt (6), has been to map out the abdomen into four anterior and four posterior fields, a dose of from 10 to 15 per cent U.S.D. applied to one anterior and one posterior field once weekly, at a target distance of from 30 to 50 cm. This treatment is continued for six months. Temperature

elevation over one degree following treatment indicates decrease of dosage. In cases in which the affected region was entirely below the umbilicus, a dose of 20 per cent U.S.D. was administered once weekly over anterior and sacral fields of sufficient size to include the lesion. In cases in which the upper abdomen was involved, the dosage was reduced. In the caseous types, the dosage applied was smaller than the above.

In the exudative form remarkable improvement can be obtained. Immediately after exposure there can be great relief of abdominal pain, shrinkage of the abdomen, drop in temperature, and disappearance of ascites. The general condition improves, appetite returns, and the patient gains weight. In some cases in which treatment was begun early, the patient became afebrile in three days, and ascites disappeared in about ten days.

The average technic to be employed is: frontal and posterior exposure with 180 kv., 6 ma., 1 mm. copper filter, 40 cm. distance, giving 200 r surface doses per field (one-third skin dose) once weekly for two months. This course may be repeated in three months. To help the roentgen effect, one may also employ heliotherapy in the form of natural or artificial sunlight.

Caution should be observed, in irradiation of the abdomen, to avoid injury to spleen and internal genitalia by overdosage. These organs are highly sensitive to x-rays. Because of scattered secondary radiation, no protection is afforded by covering these parts.

*Heliotherapy for Intestinal and Peritoneal Tuberculosis.*—Light therapy, both natural and artificial, is of definite value in the treatment of intestinal and peritoneal tuberculosis. Used alone or in combination with roentgen irradiation, it has at times proven an important adjuvant to rest and general hygienic therapy in selected cases. There is still considerable difference of opinion as to which regions of the light spectrum are most efficacious, as well as confusion as to which pathologic types of intestinal and peritoneal disease respond best. Natural heliotherapists, especially



those working in high altitudes, emphasize solar radiation and aërotherapy. On the other hand, those working in low lands and cloudy climates have stressed the use of artificial lights.

The rôle of ultra-violet energy has been established through animal and human studies. The exact part played in the clinical usage of light by the total visible spectrum is difficult to say, although in all probability it is in some way physiologically effective.

The additional part played by the action of moving air on the skin in the solar treatment of extra-pulmonary tuberculosis must not be discredited. Probably the combination of all factors contributes to the end-result.

In the choice of an artificial source of light, a sufficient quantity of radiation must be present.

For therapeutic purposes the sun, the mercury vapor arc in quartz, and the flaming carbon arc burning cored carbons filled with mixtures of carbon dust and metals have been the chief ones of practical importance. The mercury vapor lamp has been particularly developed for its emission of ultra-violet, although it emits also well in the visible part of the spectrum. A carbon arc consuming 25 amperes or more and burning specific carbons, such as "sunshine" carbons, closely approximates highland sunshine. Carbon arcs of varying amperage and with special cored carbons will emit, almost according to the needs, widely varying intensities in many regions of the light spectrum.

The erythematous reaction is really the only physiologic one that is established with a relatively high degree of accuracy. As a criterion it is a simple and practical means of preventing severe burns, and as a reaction it is a good means of judging the effectiveness of a lamp.

Exact clinical indications for different sources of light have not yet been defined. For intestinal and peritoneal tuberculosis both artificial sources of light have shown great value (7).

*Secondary Intestinal Tuberculosis.*—In an active febrile pulmonary tuberculosis complicated by active intestinal tuberculosis, *mercury quartz irradiations* have been regularly used by many for the intestinal complication and not infrequently with favorable effect. In such cases the activity and nature of the pulmonary disease have been disregarded. The unfavorable empirical results obtained when other treatments have been used justify this as an indicated therapy.

Artificial light and solar therapy, as well as a rich vitamin diet, should be used in most cases, as they frequently relieve the symptoms and bring about recovery.

Excellent results are obtained with the use of artificial sources of radiation, with general exposures either of the mercury arc in quartz or carbon arc sources. The results depend on factors such as the general status of the patient and extent and nature of the disease in the intestine. Those with far advanced pulmonary and intestinal tuberculosis with little remaining resistance cannot be expected to respond, but intestinal tuberculosis to-day is healed in many patients, and often autopsies have confirmed this.

With light exposures and hygienic treatment, the symptoms referable to the intestinal tract generally vanish during the first few months of irradiation, but the exposures should be continued for at least six months to two years. The loss of symptoms is frequently surprising, abdominal pain and discomfort disappearing, diarrhea and fever subsiding quickly, and general improvement taking place. Roentgenologic studies show that the intestinal irritability as visualized by x-ray defect clears up entirely in many instances. It is usually best to continue light therapy for many months after an apparent cure has occurred.

Patients who do not respond to light should be given roentgen treatment. General body exposures to light, combined with local roentgen irradiations in suitable doses, often yield results superior to those obtained with either one or the other.

*Peritoneal tuberculosis treated by heliotherapy* over many months, as an adjunct to rest and hygienic measures, is often markedly improved, with lessening of symptoms and local signs. When the peritoneal lesion has become quiescent, it is often possible to effect surgical removal of the primary focus, such as tube or appendix, and then, with a few more months of treatment, bring about healing of the peritoneal process.

In peritoneal tuberculosis, light therapy always deserves a trial first. The *serous exudative* type generally responds to light irradiation, both in children and in adults. The *dry proliferative form*, usually adhesive, is more refractory yet often responsive. When there have been ulcerations and large *caseous* lymph nodes, as commonly seen in children, the results are most unsatisfactory. When the disease is of long standing, healing is more difficult than when irradiation is begun a short time after onset.

Pain under light therapy usually disappears rapidly, especially in children. Large quantities of ascitic fluid may disappear in a few months. To cite examples:

Case 1 represents an unusual one of peritoneal tuberculosis. Mr. C. H. (patient of ours and of Dr. A. Hyman), in June, 1935, complained of swelling of right side of abdomen and pain in both inguinal regions, loss of weight, slight fever, nausea, and anorexia. There was a firm discrete orange-sized tumor mass in the right lumbar gutter, extending from a few inches above the umbilicus to the pelvis. There were also a few small scattered similar masses in the abdomen. History was given of pleurisy with effusion, 20 years previously. The lungs were clear. An erroneous diagnosis of retroperitoneal lymphosarcoma was made by three consulting physicians.

Sixteen treatments of roentgen irradiation of tumor dosage were given over a period of 40 days by Dr. W. Harris, of Mt. Sinai X-ray Department. The factors used were as follows: 180 kv., 0.5 mm. copper, 1 mm. aluminum filter; 46 cm.

distance, size of portal  $20 \times 24$  cm. The right side of the abdomen was cross-fired through the anterior and posterior portals, 200 r being given at each treatment. The anterior field received 1,750 r measured in air, 1,350 r being given to the right lumbar region, a total of 3,700 r. Under this intensive therapy the masses dwindled gradually in size but persistent fever,  $101^{\circ}$  to  $102^{\circ}$  F., developed. Laparotomy was performed and a quart of thick yellow pus aspirated from the liquefied tuberculous caseating peritoneal mass. The patient made an uneventful recovery and has remained clinically well.

Although the usual dosage recommended for treatment of peritoneal tuberculosis, as previously stated, is distinctly smaller than that required in the treatment of tumors, nevertheless, it may be, in the light of our experience with this case, that larger dosage is required for deep-seated infections than we have been giving them in the past. In this case the patient was treated on the basis that we were dealing with a neoplasm.

Case 2 is one of hypertrophic intestinal tuberculosis. This patient has been under medical care for the past three years, complaining of abdominal distress after meals, with sour eructation, dull ache in the right lower abdomen, irregular bowel movement, loss of weight and strength, and a chronic slightly productive cough. On examination a mass was felt in the right lower quadrant, suggesting ileocecal hypertrophic tuberculosis.

X-ray chest films showed proliferative tuberculous lesions in both upper lobes, more extensive in the right upper third; moderate leukocytosis and a slightly active sedimentation rate were found. Sputum and stool examinations, at this time, were negative for tubercle bacilli.

Re-examination of bowel after barium enema showed narrowing and irregularity of cecum and part of ascending colon, terminal ileum being also involved. Findings were suggestive of granuloma involving cecum and part of ascending colon and also terminal ileum. A diagnosis of hy-



Fig. 1. Case 2. Narrowing and irregularity of the cecum, terminal ileum, and ascending colon.

pertrophic intestinal tuberculosis was made.

Light therapy to the abdomen was carried out with daily mercury vapor quartz lamp irradiations and natural sunlight in tanning dosage. The patient improved clinically. However, the ileocecal mass persisted and there were still abdominal complaints with occasional nausea and semi-solid stool. Therefore, x-ray therapy was applied—cross-firing radiation to the anterior and posterior right abdomen, giving 200 roentgen units at each treatment for four weekly exposures. The factors employed were similar to those used in the first case: 180 kv., 0.5 mm. copper, 1 mm. aluminum filter; 46 cm. distance.

Twelve weeks following this therapy the mass was no longer palpable. The filling defect by x-ray has markedly diminished. The patient has gained 37 pounds and has remained clinically well for the past seven months.



Fig. 2. Case 2. After therapy lesion is less extensive, cecum fills better.

#### CONCLUSIONS

1. The use of roentgen-ray and light radiation for treatment of intestinal and peritoneal tuberculosis is often productive of good results, warranting more general use of these measures as adjuvants to rest and hygienic treatment.

2. A trial of tumor dosage of x-ray under careful watching is indicated in proliferative forms of intestinal and peritoneal tuberculosis that have not responded to smaller doses.

3. With x-ray treatment, best results are obtained in hyperplastic and simple proliferative forms of intestinal and peritoneal tuberculosis, and especially when applied early in ascitic forms of peritoneal tuberculosis.

4. With light therapy, both natural and artificial, the ascitic and proliferative forms of peritoneal tuberculosis as well as the proliferative and ulcerative forms of intestinal tuberculosis are generally responsive in patients not too critically ill.

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## LOCAL AND GENERAL IRRADIATION IN HODGKIN'S DISEASE<sup>1</sup>

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IRRADIATION remains the chief resource in the treatment of Hodgkin's disease. Surgery is worth considering only in the earliest stages of those rare cases in which the apparent first focus of the disease is limited to an accessible group of lymph nodes. Even in such cases, early additional treatment of the affected zone and contiguous lymph node areas by irradiation seems imperative.

All the attempts to prove various theories of the cause of Hodgkin's disease and to devise, based on those theories, more or less specific methods of constitutional treatment, have failed to produce results sufficiently impressive to lead to abandonment of radiation therapy. That fact stands as the best proof of the actual lack of general value of any of these proposed constitutional methods.

However, the search for etiology and a possible specific constitutional remedy should be pursued, for there is much about Hodgkin's disease that forbids its classification strictly as a tumor process, and that indicates that it begins, at least, as an inflammatory disease. From a clinical standpoint the fever, the rashes, the eosinophilia, the local and general distribution and modes of extension of infiltrations, the frequent traces of allergic phenomena, the common polynuclear leukocytosis, all point to an inflammatory rather than a truly neoplastic nature.

Yet, until something better is found we must do our best with the proven palliative agent, radiation.

Accepting, then, radiation as the present best available agent for the treatment of Hodgkin's disease, we may next inquire whether there is any preference as to the technic of irradiation.

It is extremely difficult to draw conclusions concerning the merits of various technics, either from a study of reported series of cases or from a review of one's own material. The difficulty of drawing conclusions is due to (1) wide variations in recommendations made by different authors, when they attempt to lay down general rules; (2) necessary wide variations of technic in any series of cases, or even in one case, because of the great diversity in types of lesions. In a disease so variable, statistics of length of survival in small series of cases mean but little, and in a disease in which no stable technic of treatment can readily be developed it is next to impossible to draw valid conclusions even from a large series of cases.

Some have attempted to distinguish between cases treated "according to plan"—that is, cases in which full co-operation of the patient was received, and all the treatment was given in the way in which the clinician intended it should be given, and cases not so treated, and to report their results on the cases supposedly ideally treated. Under practical conditions it would seem very difficult to say that very many cases could be treated just as one would wish.

Looking back to fifteen or seventeen years ago and comparing methods of irradiation of Hodgkin's disease then with current methods, one can trace a considerable evolution. In the early 1920's x-ray treatment of Hodgkin's disease was almost exclusively by low voltage x-rays, directed to the more obvious seats of disease, that is, to external masses of nodes, to mediastinal masses, and to the spleen. It was customary to give to each area to be treated single erythema or suberythema doses of low voltage x-rays (100 to 135 kv., 25 to 30 cm. T.S.D., 3 to 4 mm. Al filtration).

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

Results, as far as these more readily discernible foci were concerned, were approximately the same as now; that is, being in the main a radiosensitive disease, it responded usually with good regression of these evident foci. However, little was done for the more advanced cases with their deeper foci, of which in those days we were often not aware until autopsy was done.

Toward the latter part of the 1920's the increased availability of high voltage x-rays led to increased use of this more penetrating agent. At the same time, we were beginning to pay more attention to foci of disease which theretofore had been rather neglected. That is, we were more alert to irradiate the mediastinum and retroperitoneal region, and to follow some plan of irradiation of lymph node areas that were reasonably certain to be involved, even though no gross foci could be demonstrated in them. For example, if a packet of diseased nodes was found at the base of the neck and also in the axilla, we began to favor irradiation of the mediastinum and possibly of the upper retroperitoneal region even in the absence of demonstrable disease in those areas. We did so because experience at the autopsy table and reflection upon the apparent source and mode of extension of the disease led us to believe that Hodgkin's disease actually arises commonly in internal foci, and that if we confined our treatment to irradiation of the masses in the neck and in the axilla we would be treating only the superficial manifestations of the process. At this period treatments usually were of the order of 500 to 700 r of high voltage x-rays (185 to 200 kv., 30 to 50 cm. T.S.D., and 0.5 mm. Cu filtration). However, we never pursued a plan of systematic local irradiation of all lymph node areas, including those not even presumably involved.

The next step in the late 1920's and early 1930's was that we began to pay more attention to a search for more obscure foci. We began to suspect and find nasopharyngeal, pulmonary, gastro-intestinal, and other visceral foci, and lesions of the bones.

Then, about this time, the wave of enthusiasm for the divided dose technic led to increasing experiments with smaller and repeated doses to each area. In general, the divided dose method seems to be the prevailing one in most centers to-day. While there are, of course, wide variations in the mode of application of divided doses, the general tendency in recent years has been to use not much over 200 r of high voltage x-rays to one area at a time—frequently considerably less—and to give additional fractional doses at various intervals, depending on the individual indications, until a comparatively large total dose has been given, in the order of anywhere from 1,200 to 2,000 r or more to each field.

Such a method of treating Hodgkin's disease may work very well, particularly in clinics where there is time and space to permit a great deal of individual attention to each patient. However, it has serious disadvantages, particularly in cases that have many areas to be treated. The large total amount of body dose received by such patients frequently results in a considerable depletion of strength and depression of hematopoietic function. The frequent trips which ambulatory patients must make to the clinic in order to complete a protracted series of treatments contribute to their exhaustion.

Looking back, again, to the cases treated before we began to fractionate our doses to the present degree, we gain a growing impression that with fewer and larger doses they fared with much less exertion, they obtained good regressions, they seemed to suffer from anemia and leukopenia less commonly than the later cases, and some of them are now among the longest survivors. Of course, in forming such a judgment we must be mindful of the fact that the cases treated by divided doses are more recent, and that not enough time has yet elapsed to enable us to say whether they will show as good a survival rate. However, we are rather definitely forming the impression that, in general, it may be advantageous to return whenever possible to treatment by a smaller number of doses

per field, using larger single doses, of the order of 400 to 600 r.

The question of the choice between 140 kv. x-rays and 200 kv. x-rays, like most other questions as to choice of technic in the treatment of a variable disease like Hodgkin's disease, cannot well be settled by statistics, but rests on impressions gained by experience. Regression of superficial nodes can no doubt be brought about satisfactorily by low voltage x-rays, but it seems to me that 200 kv. x-rays offer enough advantage in added depth dose—and in the corollary, relative sparing of damage to skin and subcutaneous tissue—to call for their use in most of the lesions except the most superficial ones. Certainly for deep-seated lesions there appears to be little justification for the idea of using 140 kv. x-rays routinely, and saving high voltage for use in the later, more refractory stages. It would seem to be much preferable to treat deeply situated lesions by high voltage x-rays from the beginning.

The foregoing brief summary of evolution of methods of local irradiation for Hodgkin's disease has brought us from the earlier simpler methods of irradiation of obvious masses of enlarged nodes and spleen to the later, much more complicated, attempts to treat all the foci of the disease.

It has rather tardily come to be recognized that the treatment of Hodgkin's disease is much more complex than the irradiation simply of certain lymph node areas. A survey of any considerable group of cases, closely followed, shows that practically any tissue or organ of the body may be directly or indirectly affected. Many types of involvement of nervous system, central or peripheral, destructive or productive lesions of bones, pleural and peritoneal effusions, lesions of gastro-intestinal and urinary tracts, bizarre dermatological lesions, are among the complications that may arise.

We have in our files from 1918 to December, 1935, 339 cases diagnosed as Hodgkin's disease. Of those cases, 220 have been considered, after careful review, as being

satisfactorily proved by biopsy. It is of interest to note briefly the occurrence in this series of some complications or features of the disease which pose special problems for treatment (Table I).

TABLE I.—SOME COMPLICATIONS OF HODGKIN'S DISEASE, OCCURRING IN A SERIES OF 220 CASES VERIFIED BY BIOPSY

Admitted between Jan. 1, 1918, and Dec. 31, 1935

Lesions of the lung	29 per cent
Pleural effusion	17 per cent
Ascites	8 per cent
Jaundice	6 per cent
Itching	29 per cent
Various cutaneous lesions	13 per cent
Herpes zoster	4 per cent
Various neurological lesions	12 per cent
Lesions of bones	18 per cent

No doubt all the percentages shown in Table I would be considerably increased if we had an opportunity to follow all cases to their termination. Those enumerated are merely some of the leading complications. To mention all the others which we have observed or which have been noted by others would make an extremely long list containing symptoms referable to all tissues and parts of the body.

Thus a full acquaintance with all the possibilities of Hodgkin's disease carries one into all domains of medicine and there is no specialist who may not at some time have to meet some feature of this disease as it affects his particular interest. Thus, this one type alone of the protean lymphomatous diseases may stand as an example of the necessity for the unity of medicine, an idea to which this Congress is dedicated.

The great diversity of lesions found in Hodgkin's disease will probably always inhibit the establishment of any routine of treatment, certainly at least of any routine method of irradiation. Irradiation for Hodgkin's disease will, no doubt, always have to be individualized. Yet, within the limits of individualized treatment, there is a rather wide latitude, permitting varied technics, any of which may secure good palliation. It is doubtful whether for any case as a whole we shall ever be in a position to say that so, and just so, should that

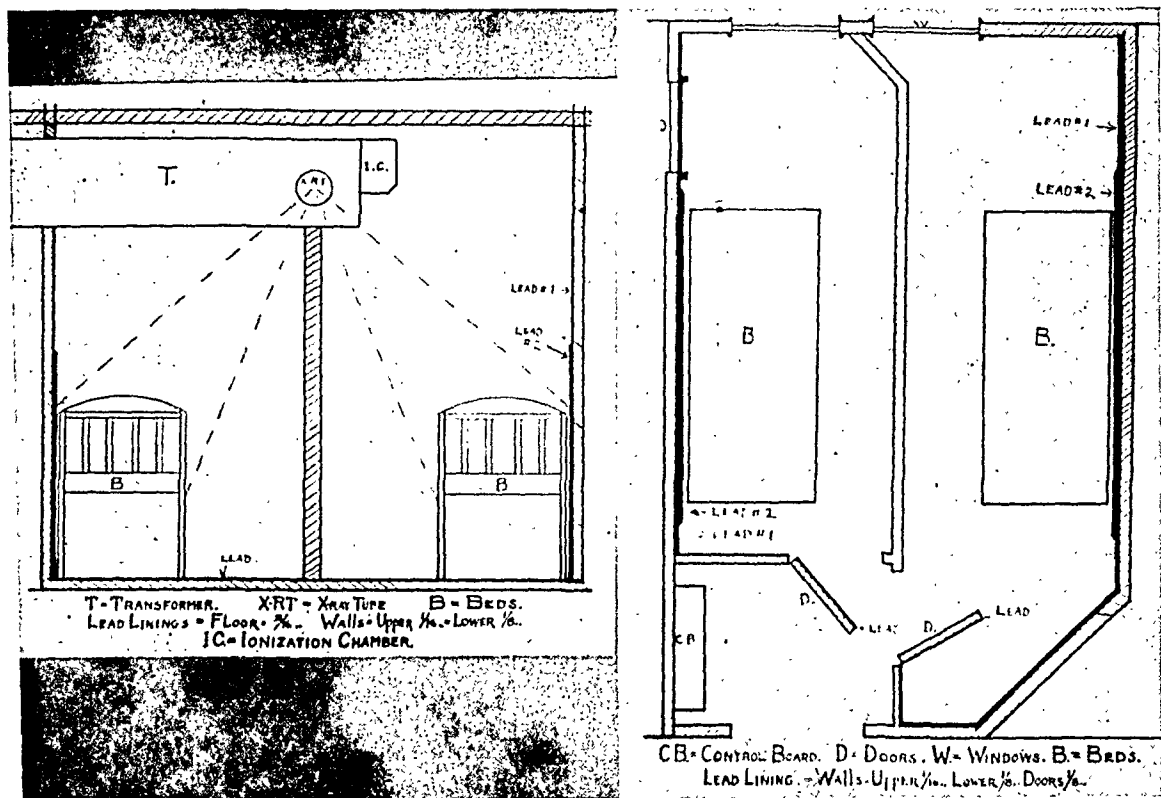


Fig. 1. Diagram of present Heublein unit for irradiation of the entire body.

case be treated. Such a routine may possibly be worked out for a given mass of nodes, but not for all the manifestations to which the case may become subject.

Various adjuvants to treatment are noteworthy. It is important for the patient with Hodgkin's disease to pursue a regimen as for tuberculosis. Rest, good diet, and sunshine are great aids in improving his condition. Transfusions, when he becomes anemic, may be of marked benefit, particularly by putting him into better condition to withstand further irradiation. Quite frequently transfusions produce alarming febrile reactions, despite great care in blood grouping and cross-matching. In some such instances, however, we have found the patient improved following such a reaction.

Irradiation of the entire body as a method of treatment of Hodgkin's disease as well as of the other lymphomatous diseases, has attracted considerable interest in certain centers in Europe and to some extent in America in the last decade. For

the most part, the whole body has been irradiated intermittently, the dose per sitting usually not exceeding 25 or 30 r. At Memorial Hospital we have employed the Heublein method, whereby the patient remains in a room sometimes for several days at a time (Fig. 1), receiving radiation from a tube at a distance of from 7.3 to 3.4 meters (1). The factors are so adjusted that the intensity is of the order of 1 r per hour: each 24 hours the patient receives about 18 to 20 r. Our total dosage for Hodgkin's disease has varied from 38 to 300 r, and is usually 50 to 75 r.

Our experience with the Heublein method began six years ago, in May, 1931, when the first unit was established. It was used for two years, being abandoned in May, 1933, only for reasons of economy. With that unit, 44 cases of Hodgkin's disease were treated. Three cases were treated by that method alone before the unit was abandoned.

On the basis of the experience gained with that unit a report was read at the



First American Congress of Radiology, in Chicago, in September, 1933 (2), summarizing the treatment of 134 cases of generalized neoplasms, including the 44 cases of Hodgkin's disease. In regard to this disease it was concluded that irradiation of the entire body appeared to be a valuable adjunct to local irradiation, although not satisfactory as the sole method of irradiation. Bulky masses could not be satisfactorily treated by local irradiation, but if the main foci were satisfactorily treated by local irradiation, the addition of small doses of general irradiation seemed to contribute sometimes a certain tonic effect, and some of the patients seemed to have longer periods of freedom from renewed disease activity than they would otherwise have been expected to have. These results were attributed mainly to the effects on small latent or obscure foci which would not have been reached by local treatments.

In June, 1935, a second Heublein unit was installed on a more economical basis, and is still in use, so that we have had over two years' further experience with this method. Reviewing the work with the first unit, we felt our experience with it had been sufficient to establish fairly well that its field of usefulness was as an adjunct to local therapy. Therefore, in employing the new unit we have taken the position that it would be unfair to patients to restrict their treatment to general irradiation in a further attempt to see what it alone would do, and accordingly all cases treated by the second unit have also had local irradiation, before, during, or after the general treatment. Naturally it is very difficult to differentiate between the effects produced by local irradiation and those due to treatment of the entire body.

We have treated with the second unit, up to April 18, 1937, 45 patients with Hodgkin's disease. Of these, four had been treated previously with the old unit, so that we have a grand total of 44 plus 41, or 85 patients treated by this method.

Of the 44 patients treated by the first Heublein unit, ten are still living, from four

to nearly six years following that treatment. Only two of these ten patients are in poor condition. Two appear to have no disease activity, four and a third years following the first Heublein treatment. These two, and two others of the ten, have had treatment by the new as well as by the old unit.

As to the results from our second period of use of this method, during the past two years, it is impossible to give statistics because of the fact that local irradiation has also been used. It seems safe to state, however, that the impressions gained as a result of use of the former unit have been confirmed in many instances. In other words, although the general irradiation is usually followed by a period of weakness, leukopenia, and some anemia, there is frequently observed later a tonic effect, with gain of weight, some degree of regression of enlarged lymph nodes, and a longer interval before further treatment becomes necessary than could otherwise be expected.

In treating Hodgkin's disease at Memorial Hospital we have concentrated our efforts on close observation of our patients, on a search for obscure lesions, and on seeking to improve our technic of irradiation. Such results as we have are attributed to these efforts. We speak of five-year results as "survivals" rather than "cures." A recent analysis of our cases admitted between Jan. 1, 1918, and Dec. 31, 1930, and carrying results up to Dec. 31, 1935, has rejected a few cases formerly accepted as proven by biopsy, leaving 121 cases re-

TABLE II.—FIVE-YEAR SURVIVALS IN HODGKIN'S DISEASE

Admitted Jan. 1, 1918, to Dec. 31, 1930		
Total No. Proved by Biopsy	Five-year Survivals	
	No.	Per Cent
121	21	17

garded as so proven. Of this group, 21 patients (or 17 per cent) survived for five years or longer (Table II).

#### SUMMARY

1. The treatment of Hodgkin's disease by modern standards is much more com-

plex than the irradiation simply of certain lymph node areas.

2. The great diversity of lesions found in this disease will probably always inhibit the establishment of any routine as the treatment of choice.

3. While different technics may produce palliation, a review of the cases treated at Memorial Hospital leads to an impression that in local irradiation the use, wherever feasible, of fewer but larger doses may, in general, be preferable to protracted cycles of fractional dosage.

4. Irradiation of the entire body ap-

pears to have a definite place as an adjunct to local irradiation in the treatment of Hodgkin's disease.

5. Of 121 proven cases of Hodgkin's disease, 17 per cent showed a survival of five years or longer.

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# OBSERVATIONS ON THE RADIOLOGICAL CHEST VOLUME DURING ARTIFICIAL PNEUMOPERITONEUM TREATMENT

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HERE is no report in the medical literature dealing with the effect of artificial pneumoperitoneum upon the volume of the lung. The object of this paper is the presentation of the results of an investigation concerning this problem. Since 1929, when I began to use pneumoperitoneum for the treatment of tuberculous enterocolitis, I have observed that in some of my patients not only the intestinal condition improved but also symptoms originating from their pulmonary tuberculosis were favorably influenced. These observations were reported by me in 1931 (1). At the same time the problem of treating pulmonary tuberculosis by artificial pneumoperitoneum was also discussed. This treatment has been in use at Muirdale Sanatorium since that time either as an independent therapeutic measure or in combination with surgical paralysis of the phrenic nerve (2). It is used mainly in cases in which other local mechanical measures, such as artificial pneumothorax, phrenic nerve block, or thoracoplasty are technically impossible, unsatisfactory, or contra-indicated. In several of my pneumoperitoneum patients artificial pneumothorax failed either because there was no free pleural space when the injection was first attempted or because the pleural space became obliterated by adhesions during pneumothorax treatment. Pneumoperitoneum proved to be of value in patients in whom a bilateral treatment was indicated, but the extensive involvement of both lungs contra-indicated a bilateral artificial pneumothorax. Patients past 50 years of age tolerate pneumoperitoneum treatment better than bilateral pneumothorax. Basal forms of pulmonary tuberculosis respond particularly well to pneumoperitoneum. Furthermore, it may be of some value in patients in whom thoracoplasty would be the treatment of

choice, but is disregarded because of the age or general debility of the patient, or because of the bilateral extent of the disease. Some benefit from this treatment may be expected in patients who refuse to accept thoracoplasty.

The subjective and objective responses to this treatment have been reported in previous communications (3). It may be stated briefly that favorable changes in the character, severity, frequency, and duration of cough were noted. At the beginning, the amount of sputum is increased, but, as a rule, it is expectorated with less effort and strain, while it is likely to decrease substantially during the subsequent course of the treatment. Patients who respond well, show roentgenologic evidence of clearing of the tuberculous process, sometimes diminution in size or closure of cavities. Concomitant changes in the patient's general condition were often observed, such as the disappearance of malaise, increased appetite, and gain in strength and weight.

The clinical improvement in some of my patients was comparable with that seen after artificial pneumothorax or phrenic nerve block. On the basis of analogy one is justified in assuming that the therapeutic effect of pneumoperitoneum must be actuated by the same factors that are active in pneumothorax and phrenic nerve block. The most important of these factors are: (1) relaxation of the diseased lung tissue; (2) relative passive congestion, and (3) lymph stasis. Pulmonary relaxation facilitates the drainage and elimination of muco-purulent products from the bronchial tract. A relative passive congestion signifies the presence of a large number of defense elements of the blood, and an increased carbon dioxide concentration. The potential benefits of the latter were presented in a previous paper (4). Lymph

TABLE I.—NUMBER OF INSTANCES WITH REDUCTION OF THE RADIOLOGICAL CHEST

Number of Treatments	More Diseased Lung				Less Diseased Lung				R. Lung, Disease Same as in L. Lung				L. Lung, Disease Same as in R. Lung				Total
	Reduction		No Reduction		Reduction		No Reduction		Reduction		No Reduction		Reduction		No Reduction		
1	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	68
3	13	9	2	6	10	8	5	7	2	2			2	1			4
4	4	3		1	4	1		3	1	1				1			16
5		1	1		2			1									4
6	2	2			1	1	1	1									8
7	1	1				1	1	1									4
8		1	1			1	1	1									4
9	3	3			2	3	1	1									12
10	3	3			3	2		1									12
12	1	1			1	1											4
13	2	2			2	1		1									8
14	2	2			1	2	1	1									8
15	5	4		1	3	5	2		2	3	1		3	3			32
16	1	2			1	1	1	1	1	1			1	1			12
17	2	2			2	1		1									8
19	4	4			3	4	1										16
20	1			1	1	1		1									4
21	2	2	1	1	3	2		1									12
25	1	1			1	1											4
Total	47	43	6	10	40	36	14	16	6	7	1		7	6	1	1	240
Total	90		16		76		30		13		1		13		1		

Abbreviations: R. = right; L. = left.

stasis favors fibrous tissue formation.

This study was undertaken for the purpose of ascertaining accurately the presence and extent of pulmonary relaxation during pneumoperitoneum treatment. The estimation of the radiological chest volume was thought to be the most suitable procedure. This method was described by Hurtado and Fray in 1933 (5). They found that the best approximate value of the chest cavity could be obtained from combined external and radiological measurements. The radiological chest volume is calculated by multiplying the area of the lung fields, including the heart, measured in radiological films, by the anteroposterior diameter of the chest determined externally. In the present study the original method of Hurtado and Fray was somewhat modified. Films were taken at the end of maximum inspiration and expiration, from a distance of six feet, with the patient in the upright position. The area of the right and left lung was measured separately. It was outlined by marking the upper margin of the apices, the inner margin of the ribs, and the dome of the diaphragm. The line separating the two lungs was drawn

along the middle of the trachea and mediastinum. The measurements were made with the aid of a planimeter, the tracer arm of which was carried along the circumference of the lung. The figures on the differential wheel of the planimeter indicated areas in square centimeters.

An unselected group of 40 patients was studied, all of whom were receiving pneumoperitoneum for the treatment of their pulmonary tuberculosis. Of these patients, eight had moderately advanced and 32 far advanced tuberculosis according to the classification of the National Tuberculosis Association. The amount of injected air varied from 500 to 1,000 c.c. at each treatment. The injections were given at weekly intervals at the beginning, and two weeks apart when the pneumoperitoneum was well established.

The radiological chest volume was measured in 17 instances after the first treatment, in one after the third, in four after the fourth, in one after the fifth, in two after the sixth, in one after the seventh, in one after the eighth, in three after the ninth, in three after the tenth, in one after the twelfth, in two after the thirteenth,

in two after the fourteenth, in eight after the fifteenth, in three after the sixteenth, in two after the seventeenth, in four after the nineteenth, in one after the twentieth, in three after the twenty-first, and in one after the twenty-fifth treatment. These represent a total of 60 instances, each with four measurements. Including 160 measurements made before the treatment, altogether 400 measurements were analyzed. The results are presented in Tables I and II.

It was found that in cases with bilateral pulmonary involvement a reduction in the volume of more diseased lung was rather more frequent than in that of the less diseased lung. The explanation of this difference can be found in the increased contractility of the more involved lung tissue. To the same factor is attributable the fact that reduction of the pulmonary volume was absent in almost twice as many instances on the less diseased side than on the more diseased side. In the latter group, out of 106 observations, reduction was absent in 16 (15 per cent), while in the former group, with the same number of observations, it was absent in 30 (28.3 per cent).

TABLE II.—MAXIMUM REDUCTION OF THE RADIOLOGICAL CHEST VOLUME

Number of Treatments	More Diseased Lung				Less Diseased Lung				Equal Disease in Both Lungs			
	Reduction		No Reduction		Reduction		No Reduction		Reduction		No Reduction	
	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.	Inspir.	Expir.
1	15	11	2	6	13	27	5	7	6	4		1
3	2	11							13	8		
4	2	11		1	8	9		3				
5		4	1		3	13	1	1				
6	24*	15*			3	13	1					
7	11	7				8	1					
8	19		1			4	1					
9	14	10			16	13	1					
10	21*	14			10	11		1				
12	13	12			18	9						
13	32*	57*			10	17		1				
14	7*	21*			3	7	1					
15	39*	49*		1	23	34	2		24	25	1	
16	3	6	1		8	18	1	1	22	19		
17	14	15			9	8		1				
19	34	35			18	46	1					
20	1			1	4	1						
21	11	6	1	1	6	9		1				
25	6	5			5	13						

\* Phrenic nerve block and pneumoperitoneum.

In patients who had about equal involvement of the two lungs, reduction of the volume or absence of reduction were seen in an equal number of instances on the two sides.

Following the first treatment, 68 measurements were made. The more diseased lung showed a reduction of the volume on inspiration in 13 instances, and on expiration in nine instances out of a total of 15. This reduction is responsible for the oftentimes markedly increased amount of expectorated muco-purulent material following the institution of pneumoperitoneum treatment.

As to the degree of reduction of the lung volume three observations are noteworthy:

1. When pneumoperitoneum treatment is continued for a reasonable length of time (two months or longer), a therapeutically satisfactory reduction of the lung volume can be established, with the exception of relatively few cases in which extensive pleural adhesions prevent the rise of the diaphragm.

2. Not all patients show equal results with equal amounts of injected air and after equal number of treatments. The marked differences are attributable to the type and extent of the tuberculous lesion, the presence or absence of pleural adhesions, and the abdominal accommodation. Injection of substantial amounts of air into the abdominal cavity is followed by an increased intra-abdominal pressure. The latter is followed by a reflex relaxation of the abdominal wall, and by a rise of the diaphragm. Variations in this reflex and in the tonicity of the muscles of the abdominal wall and the diaphragm are responsible for the variations in the abdominal accommodation and in the consequent reduction of the lung volume. Thus, it is readily understandable why this reduction is not predictable and why the accompanying pulmonary relaxation is not as easily manageable as pulmonary collapse during artificial pneumothorax treatment.

3. The combination of the surgical paralysis of the phrenic nerve with pneumoperitoneum is far superior to either of

these procedures alone. The greatest reduction of the pulmonary volume was seen in instances in which this combination treatment was employed.

The maximum reduction of the volume after ten or more treatments was, on inspiration, 34 per cent and, on expiration, 35 per cent without a phrenic nerve block. According to my experience such a marked relaxation of the lung without phrenic nerve surgery is the exception rather than the rule. The average reduction of the lung volume after ten or more treatments was, on the more diseased side, 11.3 per cent on inspiration and 15.6 per cent on expiration; on the less diseased side the corresponding figures were 8.7 per cent and 14 per cent, respectively.

## CONCLUSIONS

1. Four hundred measurements were made for the purpose of ascertaining the effect of pneumoperitoneum upon the lung volume.

2. Evidence is presented that the sustained use of artificial pneumoperitoneum treatment is capable of inducing an elevation of the diaphragm and a reduction of the lung volume in the great majority of cases.

3. The beneficial results in the treatment of certain types of pulmonary tuberculosis by artificial pneumoperitoneum are attributable to the reduction of the lung volume and to the consequent relaxation of the diseased lung.

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# SOME BIOLOGICAL EXPERIMENTS WITH A CONDENSER DISCHARGE TYPE OF X-RAY TUBE

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THE question of the validity of the ordinary Bunsen-Roscoe reciprocity law for the biological effects of radiation has long been a moot one, and satisfactory evidence on either side has not been forthcoming. The principal reason for its absence has lain in the lack of availability of suitable physical equipment, which would permit a sufficient increase in the intensity of applied x-radiation to test the law over a very large range.

Such equipment has recently been designed by Kingdon and Tanis and described by them (1). They have shown that a large and reproducible x-ray emission may be obtained by discharging a condenser through a tube containing a tungsten anode and a liquid-air-cooled mercury-pool cathode. The peak of current obtained through the tube under these conditions reaches several hundred amperes, so that the instantaneous x-ray intensity produced is extremely high.

The availability of this radiation source has made possible the conducting of a number of radiation experiments with very carefully standardized biological materials which, it is felt by the writers, are rather conclusive in their bearing upon the reciprocity problem. Some experiments have also been conducted in which very intense magnetic fields have been used in conjunction with x-radiation in biological problems, the physical equipment being of such character as to make this work also rather definitive, it is thought. It is the purpose of this paper to describe this work, first in relation to high intensity radiation, and second in connection with the imposing of high intensity magnetic fields during radiation.

*Sources and Character of Radiation.*—The source of high intensity radiation used in the experiments to be described was a

mercury-pool cathode x-ray tube operated from a 0.025 microfarad condenser charged to 105 kv. and discharged through the tube. Each discharge delivered 3.5 roentgens of radiation in a period of about  $5 \times 10^{-6}$  sec. at a point 11.5 cm. from the target. The condenser was discharged about once per second, so that the instantaneous x-ray emission reached  $4.2 \times 10^7$  r/min., while the average rate was 200 r/min.

In order to measure these high intensities of radiation a Victoreen dosimeter was placed at a considerable distance from the target (about 50 cm.), and the dose at the specimen calculated from the inverse square law. A dosimeter placed at the position of the specimen read only about half of the calculated value because of ion recombination in the chamber. A dosimeter with a smaller chamber read about two-thirds of the calculated dosage.

As a control source of radiation a Coolidge tube was used, with tungsten target, operated with a manually controlled switch to provide intermittent running. The current through the Coolidge tube was maintained at from 1 to 2 ma.

*Materials and Methods.*—Three biological test objects were used in the work; the first, a strain of thoroughly standardized eosin stock of *Drosophila melanogaster*, long used by one of us (2) in x-ray experiments of a different nature; the second, a standardized strain of *Aspergillus niger*, prepared for use in experiments with low voltage cathode rays now in progress and partially published (3), and the third, seeds of a stock of winter wheat. Failure of irradiated eggs to hatch was used as the criterion of effect with *Drosophila*, and failure to produce a visible mycelium with *Aspergillus*, while in the case of wheat the lengths of coleoptiles and roots of irradiated seeds were measured, and their

diminution constituted a measure of the effectiveness of the radiation.

*Drosophila* Eggs.—Eggs were collected on agar disks sprayed with a suspension of yeast, and the disks were mounted on

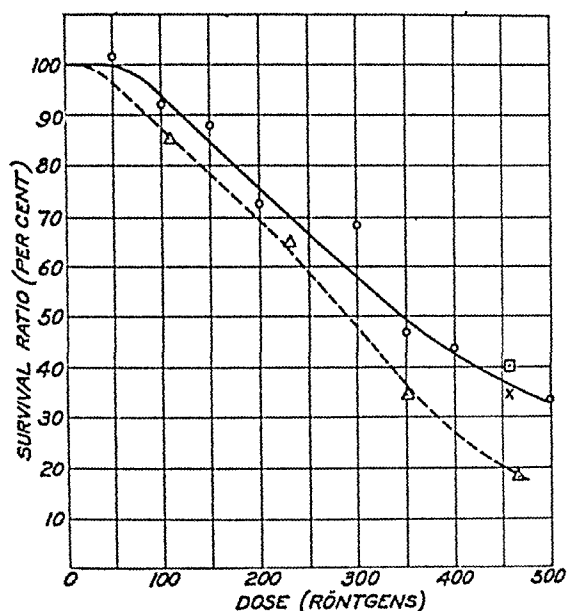


Fig. 1. Survival of eggs of *Drosophila melanogaster* as a function of x-ray dosage (full curve). The dotted curve shows comparable data from Henshaw and Henshaw.

cellophane sheets prior to radiation. All eggs were rayed at an age of less than two hours, the usual precautions being taken against the confusion of fresh with retained eggs. The percentage of survival of eggs was determined with a dissecting microscope 48 hours after irradiation, when all normal, or even considerably delayed, eggs would have hatched. The raying

was done at various times between Aug. 18 and Sept. 18, 1937, and controls were run at intervals throughout this period. All raying was done at 105 kv. The data are shown in Table I, and are plotted in Figure 1. Figure 1 also includes a curve (dotted) showing the data of Henshaw and Henshaw (4) for the x-ray killing of eggs of *Drosophila* of the same age range as ours (0-2 hours). Apparently the eggs of the eosin strain of flies used by us were somewhat more resistant to x-rays than the stock used by Henshaw and Henshaw.

For all runs made at such distance from the tube that the applied dosage was 0.33 r/shot the eggs were enclosed in a grounded aluminum case 0.05 cm. in thickness to protect the material from electrical effects due to the violent change in potential accompanying the condenser discharge. This precaution was shown by the experiments to be unnecessary, so that in the data given in the last line the material was moved closer to the tube and the dosage increased to 3.3 r/shot. This point, indicated by a square, falls close to the others in Figure 1. The comparison run with the Coolidge tube was made with the same condenser discharged through it, at an average current of 2 ma. and with the eggs at such a distance that the dosage was 3.5 r/shot, so that the data are very nearly strictly comparable. This point is shown as a cross in Figure 1, and lies close to the curve through the other points. The conclusion may fairly be drawn that a given dosage of x-rays pro-

TABLE I

Tube Used	Roentgens/Shot	Total Dosage in r	No. Eggs	No. Eggs Surviving	Percentage of Survivals	Survival Ratio
Mercury	0.33	50	771	713	92.5	101.6
"	0.33	100	806	672	83.4	91.8
"	0.33	150	811	649	80.1	87.9
"	0.33	200	1,325	875	66.1	72.7
"	0.33	300	824	513	62.3	68.5
"	0.33	350	929	394	42.1	46.7
"	0.33	400	889	357	40.2	44.2
"	0.33	500	790	245	31.1	34.2
"	0.00	0	2,294	2,085	90.9	100.0
Coolidge	3.5	467	721	231	32.1	35.3
Mercury	3.3	467	678	251	37.1	40.9



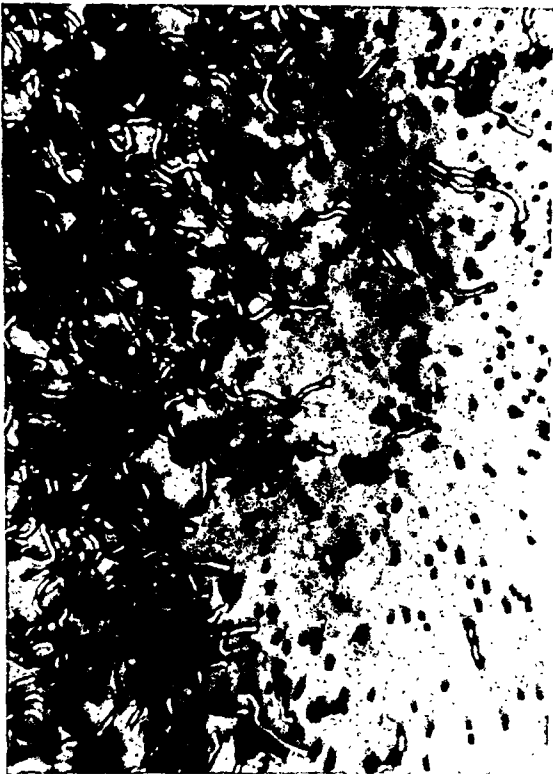


Fig. 2. Killed and germinating spores of *Aspergillus niger*. These spores have grown to a stage beyond that desirable for counting.

duces the same effect in killing the eggs of *Drosophila* whether it is delivered in low

intensity (2 ma. current) or in high intensity (400-amp. current) pulses.

*Aspergillus Niger*.—Dormant spores of *Aspergillus niger* of about two weeks of age were dusted onto narrow strips of cellophane, and four strips were mounted side by side inside the ungrounded aluminum case in front of the mercury pool cathode x-ray tube. The condenser was charged to 105 kv., and the spores received 3.4 r of x-rays per shot. When a desired dosage for one sample had been reached, it was removed and irradiation continued for the remainder. The spores were printed from the cellophane onto blocks of potato-maltose agar, and incubated for about eight hours at 30° C., after which counts were made of the number in which a mycelial beak had appeared, the low power of a microscope being used for this purpose. Figure 2 shows a photomicrograph of dead and growing spores after longer incubation (20 hours).

The experiment was repeated on the following day with the Coolidge tube. Large dosages being necessary for this experiment, the condenser was not used, since each discharge required the manual

TABLE II

Mercury-pool Cathode Tube			Coolidge Tube		
Dosage	Percentage of Survival	Survival Ratio	Dosage	Percentage of Survival	Survival Ratio
0 r	86.4	100.0	0 r	80.9	100.0
1,000	66.5	77.0	1,100	68.0	84.1
3,000	62.4	72.3	3,370	65.3	80.8
6,000	42.1	48.8	6,795	47.8	59.1
10,000	32.6	37.8	11,245	22.4	27.7

TABLE III

Mercury-pool Cathode Tube				Coolidge Tube			
Dosage	No. of Seeds	Ave. Length of Coleoptile	Survival Ratio (Percentage Average Length in Controls)	Dosage	No. of Seeds	Ave. Length of Coleoptile	Survival Ratio (Percentage Average Length in Controls)
0 r	68	30.5 mm.	100.0				
1,000	29	23.5	77.0	1,000 r	30	24.5	80.3
2,000	30	20.3	66.5	2,000	30	17.8	58.4

There is no significant difference between the results for the two tubes.

opening and closing of a switch, a condition not required by the set-up of the mercury-pool tube. The Coolidge tube

and set to germinate in a moist Petri dish. They were rayed about 18 hours after having been put to soak. Both the mer-

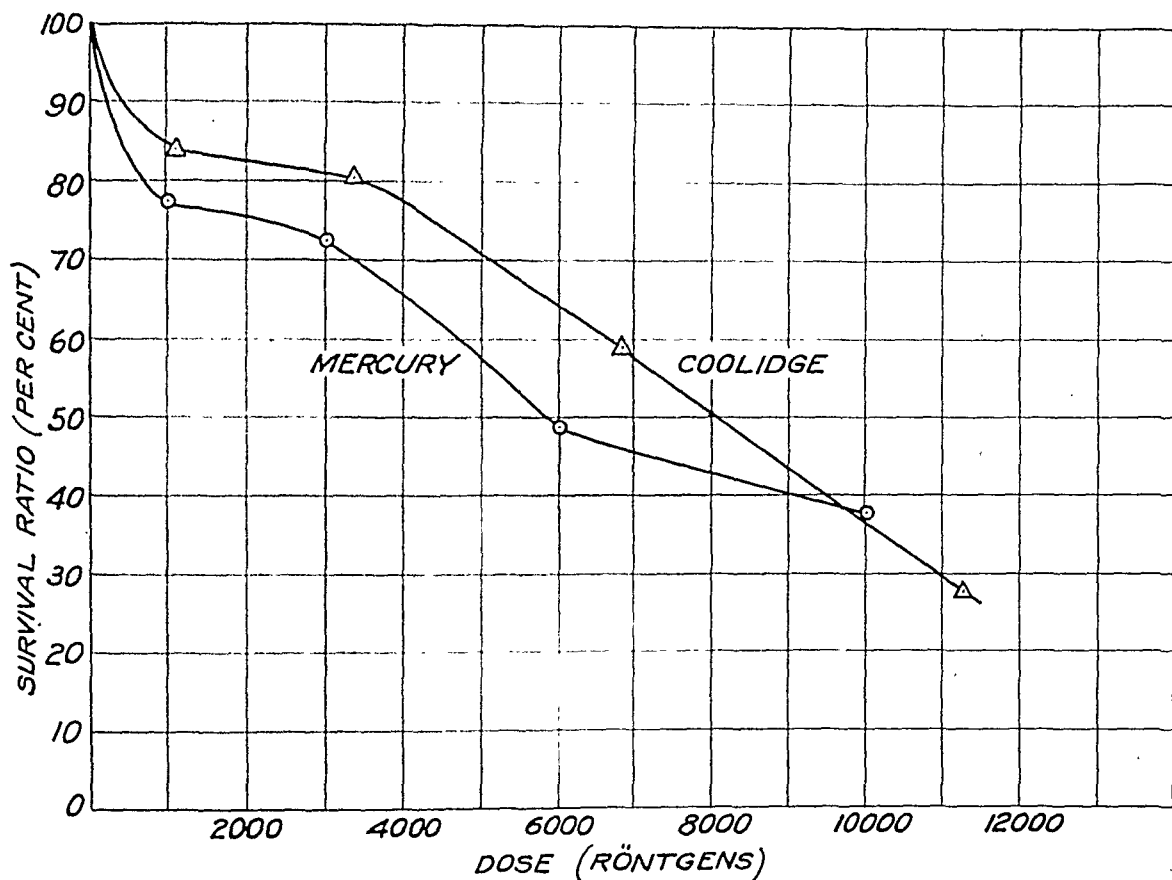


Fig. 3. Survival of spores of *Aspergillus niger* as a function of x-ray dosage.

was, therefore, run continuously at a potential of 90 kv., this potential being chosen to give approximately the same quality of radiation as that coming on the average from the condenser discharge through the mercury-pool tube. The current through the tube was 1.5 ma. The data for the two experiments are shown in Table II, and are plotted in Figure 3.

About 700 spores were counted for each point. Counting was rendered difficult by the high density of spores in some fields, and it is not thought that there is any significant difference between the two curves, indicating substantially equal effectiveness of the two types of radiation.

*Wheat Seedlings.*—Seeds of white winter wheat were soaked in tap water for 3 hours

and set to germinate in a moist Petri dish. They were rayed about 18 hours after having been put to soak. Both the mer-

cury-pool tube and the Coolidge tube were used with the condenser charged to 105 kv. and the dosage per shot for both tubes 3.4 r. The peak current for the mercury tube, as before, was about 400 amperes, while that of the Coolidge tube was 1.5 ma., so that there was a ratio of about  $2.6 \times 10^5$  between the instantaneous x-ray intensities of the two tubes.

#### DISCUSSION

The results presented above are in agreement with the work of others, using lower

intensities, who have found that the biological effects of x-rays are nearly independent of the instantaneous intensity, unless the dosages are spaced sufficiently

The latter point is discussed in some detail in the paper of Kingdon and Tanis already referred to (1), and Figure 3 is taken from that paper. In this figure the two upper

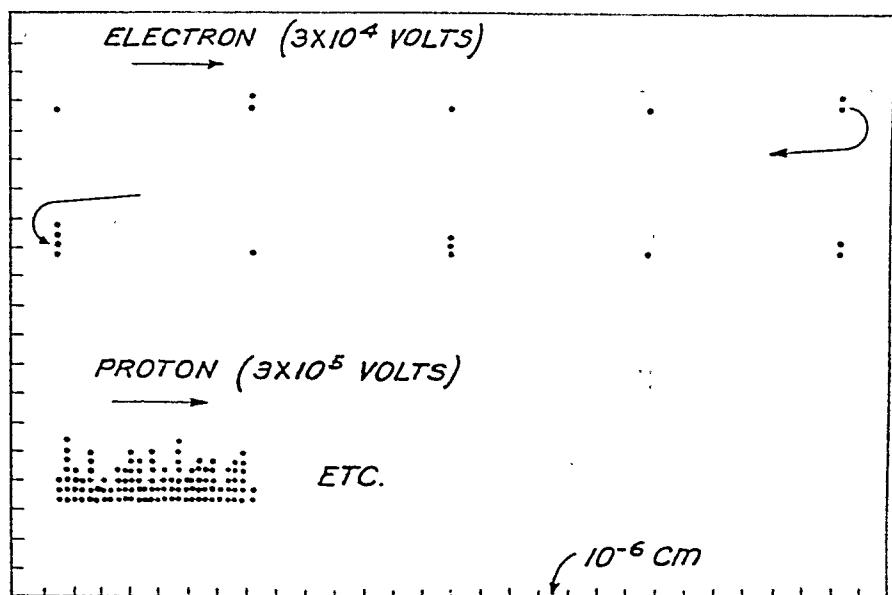


Fig. 4. Distribution of ionization along the paths of an electron and a proton in body tissue.

far apart to permit of biological recovery, which was not the case here.

Contrary to such a conclusion are the experiments reported by Lawrence, Zirkle, and their associates (5) in which the greater efficiency of neutrons in killing certain organisms is accounted for by the high intensity of ionization occurring along the track of a proton. Their experiments have shown that a given dosage of neutrons, as measured by a Victoreen dosimeter, produces a larger biological effect than an equivalent dosage of x-rays as measured by the same instrument.

These differing experimental results may be at least partially accounted for by assuming that the changing or killing of a living cell is due to the production of ionization (or excitation) in extremely small, discrete volumes within it, volumes of the order of magnitude of a single gene (radius, on the assumption of sphericity, of the order of  $5 \times 10^{-7}$  cm.) and by considering the distribution of ionization along the paths of an electron and a proton.

lines, taken in series, represent the ionization occurring along the path of a  $3 \times 10^4$  volt electron going through tissue which is taken to be 800 times as dense as air at n.t.p. Each dot represents a pair of ions (+ and -). Cloud chamber photographs in air indicate that pairs of ions may be produced singly, or may occur in groups of two or more pairs. Actually, these groups of ion pairs are spaced at random intervals—in the figure they are drawn at a constant average distance apart. Similarly the numbers of dots in each group are taken to represent the average distribution of numbers of ion pairs in the groups along the track. The scale of distances is the same on both abscissa and ordinate, so that the spacing of dots in any one group is, for electrons, predominantly closer than the spacing of groups themselves.

Below is shown a similar plot of the ionization along the path of a proton of  $3 \times 10^5$  volts in the same tissue. The energies assumed may be taken as typical for particles with which we are concerned.

If the biological killing effect of radiation is due to the production of a single ion pair in a volume of the order of magnitude of that of a gene (say, dimensions of  $5 \times 10^{-7}$  cm.), then on the basis of Figure 3 one would expect no appreciable difference in efficiency between electron and proton ionization. By far the greater portion of the ionization will be wasted, as it occurs in tissue outside the "sensitive volume," so that it would make no difference if a proton wasted a little more of its energy by producing two or three ion pairs in cases in which only one was needed. On the other hand, if the interaction requires the simultaneous production of two ion pairs in a "sensitive volume," protons should be about twice as efficient as electrons, since in only about 50 per cent of the electron ionizations can two ion pairs be produced within the "sensitive volume." This increase in efficiency is of the order reported for the neutron experiments.

Most of the experiments with the mercury-pool cathode x-ray tube were done using shots of 3.5 r delivered in  $5 \times 10^{-6}$

sec. If the ions resulting from each shot are considered to be made simultaneously, we can estimate whether their concentration is sufficient to expect differing biological effects on the basis of Figure 3. Assuming tissue to be 800 times as dense as air at atmospheric pressure, the number of ions produced in 1 c.c. of tissue for a dosage of 3.5 r will be  $5.9 \times 10^{12}$ , and the average distance between these ions will be  $5.4 \times 10^{-5}$  cm. Thus the space between tracks of individual high speed electrons will be large compared with the spacing of ions along any one track, and on the basis of Figure 3 the x-rays from the mercury-pool cathode tube should behave biologically like x-rays of ordinary intensity.

*The Effect of High Intensity Magnetic Fields.*—The biological experiments with neutrons from the cyclotron have been performed in the strong fringing magnetic field of the cyclotron. It was felt that the presence of this field might possibly produce appreciable changes in the energy levels of the molecules comprising the

TABLE IV.—WHEAT SEEDLINGS

X-ray Dosage	Strength of Field	No. Seeds	Average Total Root Length	Average Total Coleoptile Length
550 r	23,000 oersteds	23	74.6 mm.	24.2 mm.
550	0	23	56.8	19.7
0	0	20	117.7	30.8

TABLE V.—*Aspergillus* SPORES

X-ray Dosage	Strength of Field	No. Spores	Percentage of Survivals	Survival Ratio (per cent)
6,023 r	15,000 oersteds	536	53.9	60.1
0	0	442	89.6	100.0
6,023	0	567	42.9	47.3
0	0	642	90.8	100.0
6,004	15,000	434	52.9	57.5
0	0	437	92.0	100.0
6,013	0	512	62.9	68.4
0	0	498	92.0	100.0

TABLE VI.—*Drosophila* EGGS

X-ray Dosage	Strength of Field	No. Eggs	Percentage of Survivals
292	0 oersteds	96	63.5
287	23,000	105	66.6

"sensitive volume" (as in the Zeeman effect for atoms and molecules) and so increase the biological effectiveness of the radiation. Such a possibility, though remote, seemed worth testing.

A series of rough experiments was made for this purpose with x-rays from the Coolidge tube, using the stocks of wheat seedlings, *Aspergillus* spores, and *Drosophila* eggs already described. The results are shown in Tables IV, V, and VI.

In no case did the magnetic field produce a significant change in the survival. This is in agreement with the fact that the changes in energy levels as determined from Zeeman effect measurements are very small. For the fields used the maximum change in energy of a level is of the order of a few tenths of a millivolt, and as this is probably very small compared with the total energy of a level, no significant change in the target area of the molecule would be expected.

#### SUMMARY

Biological experiments are described using a condenser discharge x-ray tube capable of delivering a dose of 3.5 roentgens in five micro-seconds. Tests have been made of the validity of the Bunsen-

Roscoe reciprocity law with eggs of *Drosophila melanogaster*, spores of *Aspergillus niger*, and wheat seedlings, a Coolidge tube operated at normal intensity being used as the source of radiation for the controls. No significant differences were found in the two sets of experiments, indicating the validity of the law over the range tested.

Experiments have been made with the x-rayed material held in intense magnetic fields up to 23,000 oersteds, using the radiation from the Coolidge tube already mentioned, and the same biological materials. No appreciable effect of the magnetic field was found.

Some implications of the work are considered.

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## BONE (CALCIUM) METABOLISM IN RELATION TO INDUSTRIAL INJURY<sup>1</sup>

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**D**URING the past decade, stimulated by the work of Leriche and Policard, an enormous amount of research has been done on the physiology and metabolism of bone. It would require all the time allotted this paper simply to read the list of articles which have appeared in European and American medical journals on this subject: many notable contributions have been made which cannot even be mentioned by name in so brief a summary. These researches have brought about a complete revision in our conception of bone tissue, bone metabolism, and bone repair, but the newer facts have not yet been appropriated and utilized in the field where they are most needed, namely, that of industrial injuries.

Since the repair of a bone defect produced by injury or disease is simply a modification of the osteogenesis by which bone was originally formed, the importance which Leriche and Policard attach to this physiological process is justified. The old anatomical teaching persists in our minds that bone is the framework of the body, designed solely to support the softer tissues and provide for locomotion and other muscular actions. Usually our treatment of injuries is based on this concept of bone as a fixed and stable tissue which gradually reaches mature development and then maintains its form, structure, and mineral content unchanged, unless some injury or destructive disease attacks it. One of the most important observations of modern physiology is that no tissue in the body, with the possible exception of the blood, undergoes more rapid and striking changes, from a greater variety of influences, than the bone structure.

A better understanding of the importance of calcium and phosphorus metabo-

lism has resulted from the investigations of the past decade. Once regarded as inert minerals whose sole function was to give hardness and stability to the bones, the salts of these elements are now known to be essential and vital in the general metabolism. They are in such constant demand that a supply is stored in the bones. Leriche and Policard advance the intriguing suggestion that calcium is necessary for normal life processes and its storage must have been provided for in the very earliest stages of evolution, millions of years before locomotion entered the scheme; therefore, the deposition of calcium for storage purposes to provide for future metabolic demands must have preceded the utilization of such depots of calcium as a means of support for soft tissues and as levers for muscular movements. The functions of support and locomotion which we regard as the chief purposes of the skeletal framework were, according to this suggestion, late and fortuitous developments in the process of evolution. That idea is not only philosophic but is in line with the recently acquired knowledge that calcium is needed in the body for many other purposes besides giving stability to the skeleton, and when so needed it is rapidly removed from the bones, regardless of the effect on locomotion and support. When we place our trust in Nature to aid in healing bone injuries, we must remember that she regards the functions of locomotion and support as of secondary importance when calcium is required for more vital needs.

Our present-day concept of osteogenesis involves the deposition of calcium in a pre-formed connective tissue matrix. Whether we are considering the development of bone in the growing organism, or studying the repair of bone defects produced by injury or disease, osteogenesis requires the con-

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

verging action or concatenation of two groups of factors; one group includes the systemic or metabolic influences and the other includes the local factors. The systemic factors are (a) fundamental cellular differentiation; (b) calcium and phosphorus supply; (c) action of vitamin D; (d) parathormone control; (e) indirect metabolic influences. The local factors are (a) vascular supply; (b) cellular activity; (c) phosphatase action; (d) neurotrophic control; (e) mechanical demands. Normal osteogenesis will not take place if any one of these general or local factors is lacking. Whether one is a clinician attempting to guide the normal development of a growing individual, or a surgeon seeking to bring about repair of an injury or disease in bone, it is important that these ten factors be understood and their active participation secured.

#### SYSTEMIC FACTORS

(a) *Fundamental Cellular Differentiation.*—The old argument over the relative merits of the cellular or humoral theories of calcium deposition may never be settled, but there is no question about the origin of bone through differentiation of the primitive embryonic cells. It is an histologic fact that bone is modified connective tissue, arising originally from mesodermic cells by differentiation. It is also generally accepted that these cells first differentiate into embryonal connective tissue and from this basic type all other forms of connective tissue arise—reticular, areolar, adipose, fibrous, cartilage, and bone. When connective tissue first begins to develop in the embryo, we do not of course have all ten of these factors converging to produce bone. We have then only the phylogenetic and ontogenetic forces of evolution and heredity at work, and concerning these we have little knowledge. Until we can explain life itself, we have no explanation for the teleologic forces which initiate and carry on cellular differentiation in the embryo. Biologists dislike the term “teleology” in connection with cell activity, but until some other hypothesis is brought

forth to explain why cells differentiate, we can say only that the life purpose of the cell causes it to act as it does, and this purpose underlies any functional adaptation.

Passing by this point which is of more philosophic than practical interest, we can start with the known fact that bone is developed out of embryonic connective tissue. Whether the cells of this primitive tissue differentiate further into osteoblasts with the function of laying down calcium as a secretion, or whether the calcium is deposited mechanically in the matrix of the embryonal tissue is another unsettled point, but again, and fortunately, of academic interest only. The question which does seem to be settled is that we must have a preformed connective tissue matrix in which calcium and phosphorus can be deposited, before bone tissue will develop. While calcium may deposit in any kind of connective tissue, the more primitive this matrix is the more perfect and normal will be the resulting bone. Therefore, bone which forms in embryonic or reticular connective tissue will be more nearly normal than that which forms in fibrous or fatty tissue. Every wound in the body tissues is repaired by the formation of embryonic (granulation) connective tissue, even though this be microscopic in amount. Following the reaction of repair and development of granulation tissue, this is converted into the form of differentiated connective tissue determined by the local factors. Therefore, in the repair of bone injuries, just as in primary osteogenesis, we must first have provided a primitive connective tissue foundation. This arises in two ways: first, by the organization of the blood clot surrounding the injury, this being brought about by invasion of the clot with phagocytic cells of the blood and the eventual conversion of the clot into embryonic connective tissue; second, by the removal of the calcium from the bone at the point of injury, leaving only the connective tissue matrix. According to Leriche and Policard, this connective tissue matrix still further reverts to the embryonal stage in which calcium is most easily deposited.

In the repair of fractures, this necessary connective tissue matrix is probably formed in both ways, and calcium is then redeposited in a manner which will result in a continuous bone bridge across the injury and thus heal it. This cellular differentiation which takes place at the point of injury might seem to be a local factor, but is classed as a systemic one because it is brought about by the same general forces which underlie the differentiation of mesodermic cells in the embryo or the formation of granulation tissue wherever injuries occur in the body.

(b) *Calcium and Phosphorus Supply.*—When the necessary connective tissue matrix is present, the next essential for bone formation is an adequate amount of calcium and phosphorus in the blood stream. As previously stated, calcium is in constant demand for vital needs of metabolism. Until the general needs of the organism have been satisfied calcium will not be deposited in the bones, or if it has been deposited, it will be removed in response to such general demands. The body needs require the constant presence in the blood stream of from 9 to 11 mgm. of calcium per 100 c.c. of blood. To maintain this level, calcium must be supplied in the daily diet or else it will be taken out of the skeletal storehouse. It is well known in dietetics that the most common food deficiency is calcium. Most of the required food elements, including the vitamins, will be supplied by a general diet, but calcium will be lacking unless deliberate care is taken to supply it, or to see that the calcium-bearing portions of the foods we eat are not removed in preparing them for our tables.

(c) *Vitamin D.*—The effect of certain food deficiencies on bone growth has long been known. During the past few years it has become well established that vitamin D is a food element necessary for maintaining a supply of calcium for growing bones. It has also been fairly well established that this vitamin acts by promoting the absorption of calcium from the intestines. Unless the calcium taken in the food is absorbed into the blood, obviously it will be useless

in the body metabolism. An ordinary liberal diet will usually supply sufficient vitamin D, provided there is also enough sunshine. In cases in which there is doubt about the sufficiency of this vitamin it can be artificially supplied.

(d) *Parathormone Action.*—The secretion of the parathyroid glands maintains the calcium level of the blood. The calcium taken in as food is used for this purpose if in sufficient amount and if absorbed into the blood; otherwise calcium will be removed from the bones by action of this secretion. It is a mistaken conception to think of parathormone as governing calcium deposition; the function of the secretion is to provide for the calcium needs of general metabolism by maintaining a constant supply in the serum and plasma; only when there is a surcharge of calcium in the blood is it stored in the bones. The action of this hormone, therefore, induces a flow of calcium from the bones into the blood stream, and an excess secretion (hyperparathyroidism) brings about either a general halisteresis, or localized decalcification in the form of bone cysts.

(e) *General Metabolic Factors.*—Other internal secretions also affect calcium deposition or calcium removal. The secretions of the thyroid, the pituitary, and the gonads all influence bone growth. The bone atrophy of hyperthyroidism is quite familiar. The decalcification of pregnancy and of lactation and the atrophy of old age are other illustrations of the influence of general factors on bone metabolism.

#### LOCAL FACTORS

(a) *Local Blood Supply.*—Calcium is brought to and taken away from the bones through the blood stream. To maintain calcium equilibrium, therefore, it is necessary that the circulation through any given area of bone be stable. In fractures the injured surfaces are made ready for repair by removal of old calcium through the blood stream, and in the prepared connective tissue matrix fresh calcium brought by the blood stream is deposited. The cells which permeate the blood clot and



trophic osseous atrophy in three generations of the same family. The condition is perhaps more familiar to us in the bone changes seen in leprosy, syringomyelia, and sometimes in tabes dorsalis, in the bones of the feet and hands.

(c) *Acute Reflex Atrophy*.—Originally described by Südeck and best known by his name, it has been variously called acute painful atrophy, acute painful osteoporosis, painful osteomalacia, acute trophic atrophy, acute circulatory atrophy. In this type there occurs an irregular removal of the calcium, apparently through circulatory changes in the bone structure induced by reflex stimuli travelling over the sympathetic nerves.

(3) *Endocrine Defects*.—The deposit of calcium in bone and its removal to meet general metabolic demands will be influenced by any internal secretion which is concerned with the rate of metabolism. The thyroid gland, which exercises control over the general rate of metabolism through its influence on oxidation, includes bone tissue in its field of influence. Hyperthyroidism will bring about a removal of calcium from the skeleton in order to meet the increased demands of general metabolism. Diabetes mellitus and certain pituitary conditions, through alteration of the amount of their secretions, will break the orderly cycle of metabolism and influence the amount of calcium deposited in the bones.

The specific internal secretion which has direct control over the rapid mobilization of the calcium stored in the bones is parathormone, which is secreted by the parathyroid glands. Apparently it is through this secretion, broadcast by way of the circulation, that the demand of general metabolism for calcium is conveyed to the bones, this demand being met by flow of calcium from the bones into the circulation. An excess of parathyroid secretion results in a corresponding excess removal of calcium from the bones (halisteresis). When calcium appears in the blood stream in response to such a pathologic stimulus, and there is no real need for it, it may be rede-

posited in an irregular manner almost anywhere in the body. In hyperparathyroidism, therefore, we may have a generalized halisteresis or localized areas of calcium loss in the bones (cysts), and in addition there may be irregular and undesirable deposits of calcium in other portions of the same bone from which it has been removed, or in bones elsewhere in the body. It may be deposited in the connective tissue structures in or about the joints, such as cartilages, ligaments or tendons; it may deposit as calculi in the urinary tract; it may deposit in the connective tissue of blood vessels, in the muscles, in hematomas, in gland structures, or anywhere in the body where connective matrix is present and where the other necessary systemic and local factors converge to produce bone.

(4) *Disease Metabolism*.—There are some conditions associated with changes in the chemical condition of the blood which cause the calcium to be dissolved out of the bones. One of the most striking of these is the halisteresis of chronic arteriolar nephritis, the so-called "renal rickets." This is probably due to the inability of the kidneys to excrete phosphorus which accumulates in the blood, and must be rendered inert by combination with other salts; calcium is the most available element and is removed from the bones for this purpose. Renal rickets produces the most marked halisteresis found in any condition. Probably the decalcification which occurs at menopause and the atrophy of old age are associated with altered chemical conditions of the blood.

(5) *Specific Bone Diseases*.—Such diseases as bone infections, Schüller-Christian's disease, Niemann-Pick's disease, Paget's disease, Hodgkin's disease of bone, multiple myeloma or the osteoclastic malignancies, whether primary or metastatic, are local conditions and not essentially metabolic, and are not, therefore, considered in this paper.

#### DISCUSSION

It will be more in accord with present-day physiology to look on the skeleton as

a battleground of contending metabolic forces and to direct attention as much to those forces as to the bones themselves, when dealing with injuries. In rickets we bring about the necessary change in bone development by attention to systemic factors. In diffuse cystic osteitis, a reversal of the flow of calcium is produced by removal of the parathyroids or inhibition of their action by radiation.

In industrial injuries to bones it is necessary to pay attention to the systemic factors as well as to the local factors, if we are to secure normal and speedy repair of the injury. As illustrations of this necessity, two types of bone lesions will be briefly mentioned.

In acute reflex atrophy (Südeck's), the changes in the bones are local and due to disturbances of the sympathetic nerve control—a local factor. The treatment of this condition is based on maintenance of the circulation at a normal rate through the involved area and prevention of stasis and edema. This is done by heat, massage, and passive motion, avoiding splints and casts. At the same time, the systemic factors should not be neglected, because the process of recovery is a long one and during this time all the systemic and local factors necessary for bone repair should be maintained at optimum efficiency.

No doubt there are many patients who have excess parathyroid secretion and in whom there is a tendency for calcium to flow out of the bones; such patients may

have a generalized halisteresis without bone cyst formation. Such patients are not only more subject to bone injury, but their bone repair is rendered difficult because of this tendency to withdraw calcium instead of depositing it. Moffat has written on pathologic fractures of the spine associated with calcium metabolism; he believes that the condition is due to a faulty diet and can be diagnosed by its x-ray appearance. Ballin gives five types of parathyroid disorder, one of which—the vertebral type—is important from the industrial standpoint. Pemberton and Geddie include among the clinical features of hyperparathyroidism, rarefaction of bones with or without cyst formation, hypotonia, and muscular weakness. Bauer gives among the symptoms due to alteration of calcium and phosphorus metabolism, weakness and loss of strength, muscle and joint pains, bone tenderness, and frequent fractures from slight trauma. These symptoms have a familiar sound to the industrial surgeon who handles back injuries, and should suggest that less concentration of attention on braces, plaster casts, and adhesive taping and more consideration given to proper diet, sunshine, and vitamin D might hasten recovery in many of these cases.

Illustrations could be multiplied but the purpose of this paper is a general one, to emphasize the importance of a broader conception of injuries to bones, based on a knowledge of calcium metabolism, rather than a discussion of specific cases.

# TREATMENT OF FEMALE ENDOCRINOPATHIES<sup>1</sup>

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THE endocrine glands have, since first discovered, offered a very perplexing problem to the clinician both in diagnosis and therapy. Rapid strides have been made in the understanding of the function of the various glands and their interaction, but this is far from complete. Knowledge of the glands which control the female sex function is perhaps more advanced than in any other field of endocrinology and many of the functional disorders of the female are recognized as glandular in origin. But the mechanism of this complex function has not been sufficiently demonstrated so as to serve as a basis of specific therapy. The identity and individuality of some of the hormones have not been determined, and in many cases it has not been proven which hormones cause certain reactions. Also, endocrine disorders are not the result of the lack of or the over-abundance of a single hormone with complete normalcy of the other glands. The abnormal function of one gland is usually accompanied by decreased function in some of the other glands of the endocrine system, with compensatory hyperactivity of still others, depending upon the normal interaction of the glands.

For these reasons organotherapy is not sufficient in treating functional disorders of the female, though we have some of the hormones in pure form and in potent concentration. We have, therefore, sought some other means of treating the cases which might more nearly relieve the cause of the disorder than glandular products which are purely substitutional in action. We refer to irradiation of the pituitary gland.

This method of treatment is not very recent; however, it has been used more

extensively in Europe than in this country. It was introduced by Hofbauer (1), in 1922, before the German Gynecological Congress. Rubin (2, 3), in 1926, and Kaplan (4) reported the use of x-ray therapy to the ovaries and to the pituitary gland in cases of amenorrhea and functional sterility. Ford (6) and Drips (5), in 1928, and Collins *et al.* (7), in 1936, found irradiation helpful in relieving the symptoms associated with the menopause. Recently (1935), Newell and Pettit (8) reported excellent results in cases of functional dysmenorrhea treated with pituitary irradiation. Mazer and Spitz (9), in 1935, found irradiation helpful in the functional menstrual disorders.

In using x-ray to the pituitary gland we make no pretense of explaining its method of action. We have found that it is effective, which must be sufficient for the time being: no one as yet really knows how it works. This is attested to by the fact that there is such a wide divergence of opinion as to its *modus operandi*. Some able clinicians say that all x-ray is destructive, hence irradiation can be beneficial only when there is a state of hyperfunction, and reduction of the activity of the gland is indicated. Others base their opinion of the action upon the hypothesis that every action is accompanied by a counteraction and that in this case irradiation causes a depression which is followed by recovery of function, which may proceed to a greater activity than was formerly present, provided that depression has not been pushed to the point of complete destruction. There are still others who maintain that x-ray in small doses is stimulating or causes a hyperemia which results in stimulation of the gland. Without holding to any theory as to the mechanism of its action, we specify stimulating doses of

<sup>1</sup> Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

x-ray because we feel that the end-results are those of stimulation.

Since we use irradiation of the pituitary gland in many of the functional disorders of the female, the question naturally arises as to how one method of treatment can be effective for so many different clinical entities. In answering this, two aspects of the problem must be considered: First, we believe that the causes of most of the functional disorders of the female differ from each other more in degree than in kind, that the degree of disturbance of the ratio of the female sex hormones is the important factor in determining the clinical manifestation of that disturbance; second, the pituitary is the master gland of all endocrines. The ovary is completely under its dominance. Most of the functional disorders are not primary in the ovary but are the result of improper pituitary action. It may be asked how irradiation can affect one of the functions without affecting the others. In answer, it seems impossible for a gland of such simple histologic structure to have so many independent actions; that in cases in which there is a disturbance in one function there is probably disturbance in more. When we have adequate clinical tests for these functions this problem will be clarified.

What cases are suitable for irradiation? First of all, it should be stressed that all cases to be treated for a functional disorder should be thoroughly studied to ascertain whether there is present any pathology, local or systemic, before endocrine therapy is administered. The endocrines are, after all, only a part of the whole and as such are subject to depressant action the same as other organs. It is well known that foci of infection, anemia, psychic and emotional disturbances, etc., can affect specific functions of the body, such as cardiac action. In like manner, such factors can affect the endocrine glands. When such factors have been definitely and conclusively excluded as etiological factors, then and only then can any form of endocrine therapy be administered with any hope of success. We stress these very obvious facts be-

cause they are the most important factors in successful endocrine therapy. Though they seem obvious, they have been neglected and endocrine therapy used. When results were not forthcoming endocrine therapy has been branded as worthless. The discredit thus placed on this form of treatment is both unjust and unfair.

After the case has been established as endocrinal in origin there is no contra-indication to irradiation therapy in the small doses advocated. With these minimal doses there are no unpleasant secondary reactions other than occasional nausea or headache for a few hours. When irradiation was first used larger doses were employed and epilation occurred, but this is absent with the present dosage. X-ray used in small doses has no deleterious effects on subsequent pregnancies. Its use need not be confined to any particular age group.

We have not used irradiation exclusively and do not advocate such usage. In conditions in which organotherapy is indicated and potent products are available, we used them. We have used organotherapy alone and feel that the results thus obtained are not so good or so lasting as those obtained by organotherapy and irradiation combined.

#### AMENORRHEA

Amenorrhea is perhaps the most profound type of ovarian failure. Hormone studies of amenorrheic women usually reveal a deficiency of the estrogenic substance, the amount varying with the degree of ovarian failure. Rarely an excessive amount is found in the blood, which is attributed not to excessive production but to faulty elimination, since the urine level is usually low. The uterine scrapings almost invariably show ovarian failure, the picture which was formerly called "atrophic endometritis." Scanty and irregular menstruation indicates ovarian failure, which differs from that of complete amenorrhea only in degree.

Based on this concept of amenorrhea, what would be the logical method of therapy? If the deficiency lies in the

thyroid, the problem is comparatively simple and results are good; but if the fault lies in the gonads or the pituitary, it becomes considerably more difficult. We know that we can produce uterine bleeding, even typical progestational endometrium, by the administration of large doses of theelin and progesterin, but such a procedure will have to be repeated for each menstrual period—an expensive procedure and one of which the patient will soon tire. Furthermore, what is to be gained by it? Amenorrhea in itself is harmless. It is the underlying cause which should be corrected. There is only one justification for using ovarian hormones in amenorrhea

and that is to convert an infantile, unresponsive uterus to that of the adult type. Can we stimulate the ovaries or pituitary? At the present time, we do not have available for therapeutic use a product containing the follicle-stimulating factor of the anterior pituitary gland, which has been proven to be effective clinically. The gonadotropic substance of pregnancy urine is essentially luteinizing in character and this effect is not very marked in the human. Our one hope, at the present, of restoring the normal function of the ovary or pituitary is by irradiation of the pituitary gland. This we have used with the results as tabulated in Charts I and II.

CHART I.—AMENORRHEA

No.	Types			Treatments					Results		
	Normal	Infant.	Obese	X-ray	Thyroid	Prog.-B	Ant.-S	Proluton	Relieved	Improved	Failure
22	12	5	5	22	10	8	1	2	16	5	1

Typical Cases

Case	Age	Duration of Amenorrhea	Other Symptoms	Laboratory	Treatment	Results
C. C.	15	Never menstruated	Obesity	B.M.R.-13	Diet X-ray Thyroid	Periods q. 28 days
L. L.	27	10 months	Obesity	B.M.R. + 2 Pit.-neg. Estrin-neg.	Diet X-ray Thyroid	Started menstruating 1 mo. after x-ray; now regular
L. K.	34	3 years	Infantile	...	X-ray Ant.-S Thyroid	Regular q. 28 days

CHART II.—OLIGOMENORRHEA—HYPOMENORRHEA

No.	Treatments					Results		
	X-ray	Thyroid	Progynon-B	Ant.-S	Proluton	Relieved	Improved	Failed
20	20	7	9	4	2	13	7	0

Typical Cases

Case	Age	Menstruation	Laboratory	Treatment	Results
H. D.	27	15-5-28 scant	Estrin-neg. Pituitary-neg.	X-ray-3	Periods normal amount
L. M.	34	q. 6-8 mo.	B.M.R. - 10 Estrin very weak Pituitary-neg.	X-ray	Periods q. 28 days; became pregnant
C. R.	31	13-1/2-28	Pituitary-neg. Estrin-weak	X-ray Thyroid Proluton Progynon-B	Periods normal in amount

## FUNCTIONAL BLEEDING

The etiology of functional bleeding, which includes menorrhagia and metrorrhagia, is unknown. However, we have found that in most cases uterine scrapings reveal over-stimulation of the endometrium by the follicular hormone with decreased or absent luteal activity. The cases usually respond exceptionally well to the use of the gonadotropic hormone or the corpus luteum hormone. In difficult and resistant cases, irradiation of the pituitary is helpful, as shown in Chart III.

## DYSMENORRHEA

The etiology of functional dysmenorrhea has long been a moot question. Studies by methods which are only recently available—blood and urine hormone tests and endometrial biopsy—seem to indicate that there is a disbalance of the two ovarian hormones with a relative excess of theelin. This represents a type of ovarian failure which is usually due to insufficient stimulation of the ovary by the anterior pituitary. Treatment is directed, therefore, toward the restoration of the normal ratio

CHART III.—FUNCTIONAL BLEEDING

No.	Frequency of Bleeding	Treatments			Results	
		X-ray	Ant.-S	Thyroid	Relieved	Failure
S	Continuous to 21 days	8	4	3	6	2

## Typical Cases

Case	Age	Menstruation	Laboratory	Treatments	Results
M. B.	23	q. 14-20 days lasts 5-60 days	B.M.R. - 10	X-ray Ant.-S Lextron	Normal periods for last 10 months
S. P.	21	Continuous for 60 days	B.M.R. - 12 Hypertrophic-endometrium Estrin-positive	Splenic ray 1 X-ray Pit.-2 Pelvic Ray Proluton Thyroid Ant.-S	No results until 1,750 mg. radium in cervix
F. F.	44	q. 28 days lasts 14 days; clots	Uterine scraping; Mycotic infection	X-ray Ant.-S	Slight improvement

CHART IV.—DYSMENORRHEA

No.	Treatments				Results		
	X-ray	Ant.-S	Proluton	Thyroid	Relieved	Improved	Failure
33	33	21	7	29	29	4	0

## Typical Cases

Case	Age	Duration of Symptoms	Other Endocrine Stigmata	Treatments	Results
M. F.	27	4 years	Sterility	Irradiation Proluton Thyroid	Relieved
D. H.	24	10 years	Infantile uterus B.M.R. - 21	Irradiation Thyroid Ant.-S	Relieved
H. D.	32	12 years	Infantile build	Irradiation Proluton	Relieved

of the two hormones. Irradiation of the pituitary gland supplemented by administration of the corpus luteum hormone gives excellent results, as shown in Chart IV.

#### MENOPAUSE

The menopause syndrome is an endocrinopathy of polyglandular origin, the primary factor of which is loss of ovarian function. This is followed by a compensatory hyperfunction of the anterior pituitary gland. Other glands, as the thyroid and adrenals, are also contributory factors of more or less importance. It has been demonstrated that at the time of the menopause there is a progressive decrease of the theelin in the blood and urine, accompanied by a progressive increase in the amount of the pituitary gonadotropic hormone. Furthermore, that the subjective symptoms, as hot flashes, are due to the presence of this excessive amount of pituitary hormone. Therefore, treatment, which seeks only to control the unpleasant symptoms, should be directed toward reduction of this excess. This can be accomplished by administration of

theelin and by irradiation. The severity and duration of the symptoms will determine the mode of therapy. In mild cases, organotherapy is usually sufficient. In the more severe cases, the addition of irradiation of the pituitary gives better results than organotherapy. Results are tabulated in Chart V.

#### STERILITY

Functional sterility may occur as an accompaniment of some menstrual disorder or it may occur in an apparently normal woman with a regular menstrual cycle. The findings in the former are sufficient to explain the sterility. In the latter, the clue to the situation is found in the study of the endometrium, for which purpose a small amount of tissue is taken and examined microscopically. Normally the endometrium undergoes a cyclic change which is governed by the cyclic changes in the ovaries and from both an anatomical and physiological standpoint can be divided into two corresponding phases—the follicular and the luteal. In many of the cases of sterility we have found evidence

CHART V.—MENOPAUSE

No.	Treatments			Results		
	X-ray	Thyroid	Progynon	Relieved	Improved	Failed
20	20	3	17	13	6	1

#### Typical Cases

Case	Age	Mense.	Preg.	L.M.P.	Meno. Symptoms	Other Symptoms	Treatment	Results
McP.	53	13-6-28	4	20 yrs. before	Nervousness; occasional flash	Periodic rhinitis	X-ray	Relief for 15 mo. of nervousness and rhinitis
G. D.	43	12-4-28	2	Still menstruating	Flashes Headaches	Obesity	Progynon-B Thyroid X-ray Diet	Symptoms relieved; loss of 15 lb.
E. C.	50	3-5-28	5	1-7-35	Flashes Depression Nervousness	Obesity	Progynon-B q. 4 days for 3 mo. X-ray Pit. Tonic	Relief of all symptoms
I. R.	40	...	3	1934	Extremely nervous, felt as though were going crazy	...	X-ray Pit. Progynon-B	Cured of symptoms

of two types of ovarian failure—failure of corpus luteum formation which results in incomplete progestational changes in the endometrium or low degree of luteal differentiation, and failure of ovulation. It is now an accepted fact that menstruation can and does occur without ovulation. This phenomenon can be diagnosed by study of the endometrium which shows no evidence of progestational changes whatsoever. These anovulatory cycles are absolutely sterile cycles.

The cause of this ovarian hypofunction may be primary in either the pituitary or the ovary. The pituitary may not secrete sufficient amount of the gonadotropic hormones to carry the ovary through its complete cycle. If this is the case, x-ray therapy to the pituitary is used. The ovary may contain many follicular or corpus

luteum cysts which prevent ovulation. Here x-ray directly to the ovary is indicated. With x-ray therapy the corpus luteum hormone, progesterone, is also used to insure complete progestational proliferation of the endometrium.

There are some cases, however, which have still another contributory factor, low thyroid function; until this deficiency is corrected, they do not conceive. Results are recorded in Chart VI.

Spontaneous abortion may be considered as a type of sterility for, though the patient conceives, she is unable to carry the pregnancy to a successful conclusion. Exclusive of non-endocrine cases, the basis of this condition is also corpus luteum failure. The luteal hormone not only prepares the endometrium for reception of the ovum but, after fertilization and nidation

CHART VI.—STERILITY

No.	Years Sterile	Other Endocrine Stigmata			Treatments						Results	
		Obese Amen. Infant.			X-ray	Diet	Thyroid	Theelin	Ant.-S	Prol.	Pregnant	Failure
11	11	8	2	2	11	8	9	5	2	1	10	1

Typical Cases

Case	Years of Sterility	Age	Previous Pregnancies	Other Symptoms	Treatment	Results
H. D.	20	38	0	Headaches	X-ray Post. Pit.	Delivered by caesarean section
S. D.	10	39	2	Obesity; headaches	X-ray Thyroid Post. Pit. Diet	Twins
S. S.	3	30	0	Obesity	X-ray Thyroid Progynon-B Diet	Pregnant 1934 and 1936

CHART VII.—SUMMARY OF RESULTS

	No.	Relieved	Improved	Failure
Amenorrhea	22	16	5	1
Oligomenorrhea and Hypomenorrhea	20	13	7	0
Functional Bleeding	8	6	0	2
Dysmenorrhea	33	29	4	0
Menopause	20	13	6	1
Sterility	11	10	0	1
Total	114	87	22	5
Percentage		76.3	19.3	4.4



of the ovum have occurred, it serves to maintain pregnancy. If it is present in insufficient quantity, loss of fetus ensues. This type of abortion can be prevented by adequate administration of progesterone.

#### OBESITY

Obesity is not a clinical entity, but is a symptom which may be due to many causes. From an endocrine standpoint, it is most often due to pituitary, thyroid, or ovarian failure, singly or combined. Each case must be studied individually and treated accordingly. In the treatment of any type of obesity, diet is of first importance. Thyroid extract is helpful in most cases, but cases are encountered whose weight-reduction cannot be affected by diet or diet and thyroid. The addition of irradiation to the therapy facilitates reduction considerably.

#### SUMMARY

1. It is believed that the causes of most of the functional disorders of the female differ from each other more in degree than in kind and that the degree of disturbance of the ratio of the female sex hormones is the important factor in determining the clinical manifestations of that disturbance.

2. Most of the functional disorders are not primary in the ovary but are the result of improper pituitary action.

3. Knowledge of the physiology and chemistry of the female sex function is not complete enough to serve as a basis for specific organotherapy in disturbances of this function.

4. The combination of irradiation of the pituitary gland with appropriate hormone preparations, when they are available, is the most effective method of therapy in functional disorders of the female which we have available at the present time.

5. Various types of female endocrinopathies numbering 115 cases have been treated by combination of irradiation of the pituitary gland and organotherapy, of which 87 (76.3 per cent) were relieved, 22 (19.3 per cent) improved, and five (4.4 per cent) were failures.

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# STUDIES ON THE EFFECT OF RADIATION UPON GROWTH AND RESPIRATION OF VARIOUS TISSUES *IN VITRO*

THE LETHAL DOSE AND THE SUBLETHAL DOSE OF X-RAYS AND RADIUM:  
PRELIMINARY REPORT<sup>1</sup>

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IN spite of the extensive literature on the effect of radiation on living matter, there is no definite knowledge regarding the biological response of various tissues to different sources of radiation or the dose required to inhibit the proliferation of living cells, particularly malignant cells. Even such basic factors as the lethal dose and the sublethal dose for various types of tissues, particularly mammalian, have not been definitely determined.

In attempting to fix stable conditions for the determination of these factors the following criteria, more or less arbitrary, have been selected: (1) To determine the amount of radiation which will inhibit the growth of an explant during 48 hours' incubation following radiation. This will be termed the lethal dose. (2) The highest amount of radiation which would just permit a slight proliferation of the explant to take place. This will be called the sublethal dose.

Instead of newgrowths *in vitro* which have been subcultured several times, as used by other investigators, we have irradiated explants of freshly excised tissues as well as new active growth in primary or original cultures. A brief explanation for this use of only fresh explants and primary growth in cultures is necessary. In some quarters the objection is advanced that subcultures of several passages do not possess the same qualities as body cells. In using fresh explants and primary growth in cultures this objection is overcome, al-

though the lack of a blood supply has not been remedied.

The sources of normal mammalian fibroblasts and epithelial cells of embryonic origin were the heart, kidney, and tongue removed under aseptic precautions from two- to three-month-old human embryos and the heart and kidneys of one- to two-day-old rats. Explants of the heart from seven- to eight-day-old chick embryos, producing always 100 per cent growth *in vitro*, were used as an index for these experiments.

Explants in freshly made cultures were exposed to radiation of x-rays, radium, and radon. The dose was gradually increased until no growth of new cells from the explant took place following 48 hours of incubation after irradiation. As neoplastic tissues, human myxosarcoma of the thigh, and Mouse Sarcoma 180 were used. In order to investigate the effect of radiation on actively growing cells, primary or original cultures were used. Only those doses which were found to be sublethal or lethal for the explants were employed here.

## EXPERIMENT WITH X-RAYS

A half wave valve tube generator and a thin-walled Coolidge tube were used as the source of x-rays. The cultures were irradiated at a focal distance of 40 cm., using 200 kv. at 6 ma. with 1 mm. aluminum filter (effective wave length of 0.32 Å.). Under these conditions 80.75 r/min. was the average intensity measured in air without back-scattering. The temperature in the area of the cultures was between 30 and 35° C. during radiation.

<sup>1</sup> Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

Under these conditions explants of the above-mentioned tissues were irradiated with doses ranging from 3,000 to 30,000

was smaller in size than that of the control cultures. Fat droplets were also present in this culture which is a sign of early de-

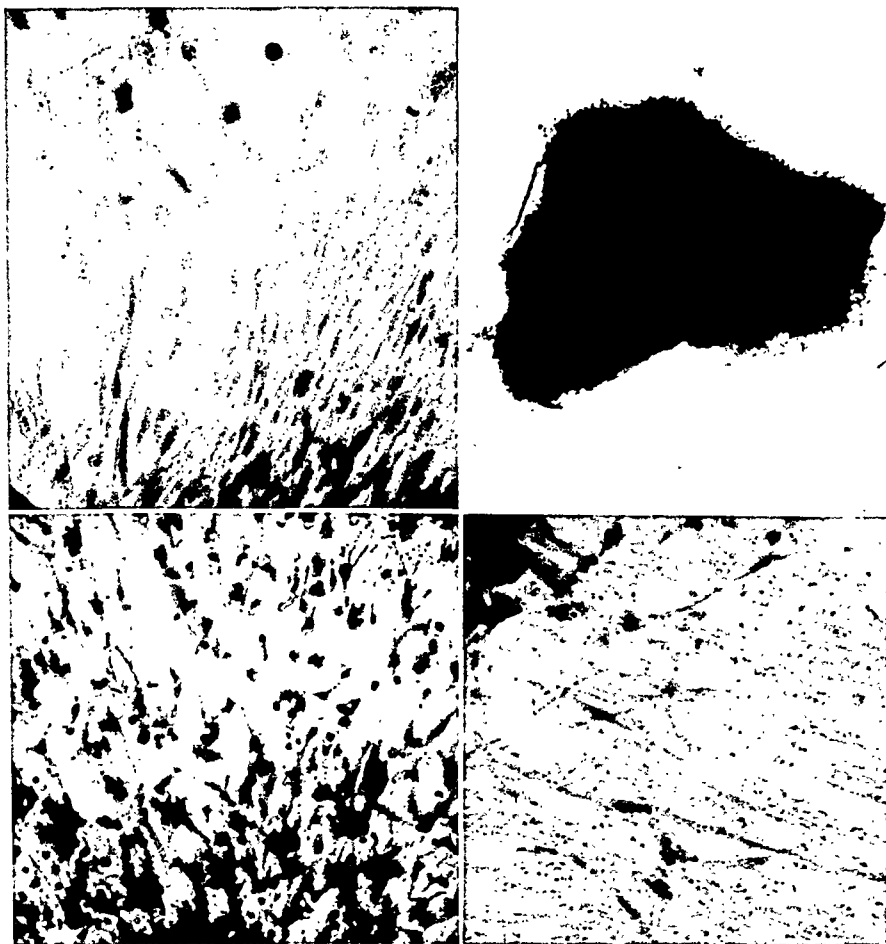


Fig. 1. An explant of embryo chick heart irradiated with 20,000 r. The growth shown in the illustration occurred during 48 hours' incubation following irradiation. The cells appear to be normal. (*Upper left.*)

Fig. 2. An explant of embryo chick heart irradiated with 30,000 r. No growth or outwandering cells are present. (*Upper right.*)

Fig. 3. A 24-hour growth *in vitro* of embryo chick heart irradiated with 30,000 r and observed 48 hours after radiation. As can be seen, the cells are degenerated, the offshoots from the fibroblasts are in most instances broken up, the protoplasm shrivelled, and the nucleus elongated or broken up. (*Lower left.*)

Fig. 4. A 24-hour growth *in vitro* of embryo chick heart as a control to Figure 3. Note the normal appearance of the cells. (*Lower right.*)

roentgens. Only the results obtained with high doses of x-ray will be reported here.

When explants of the above-mentioned tissues were irradiated with 30,000 r no growth or outwandering cells occurred in the cultures during 48 hours' incubation, while explants exposed to 20,000 r showed a fair growth during the following 48 hours' incubation. This newgrowth, however,

generation. When explants were exposed to 25,000 r just a few outwandering cells could be observed in some of the cultures during 48 hours' incubation.

Actively growing cells of fibroblasts in primary or original cultures of the above-mentioned tissues as well as of human myxosarcoma and Mouse Sarcoma 180 degenerated after they were exposed to radia-

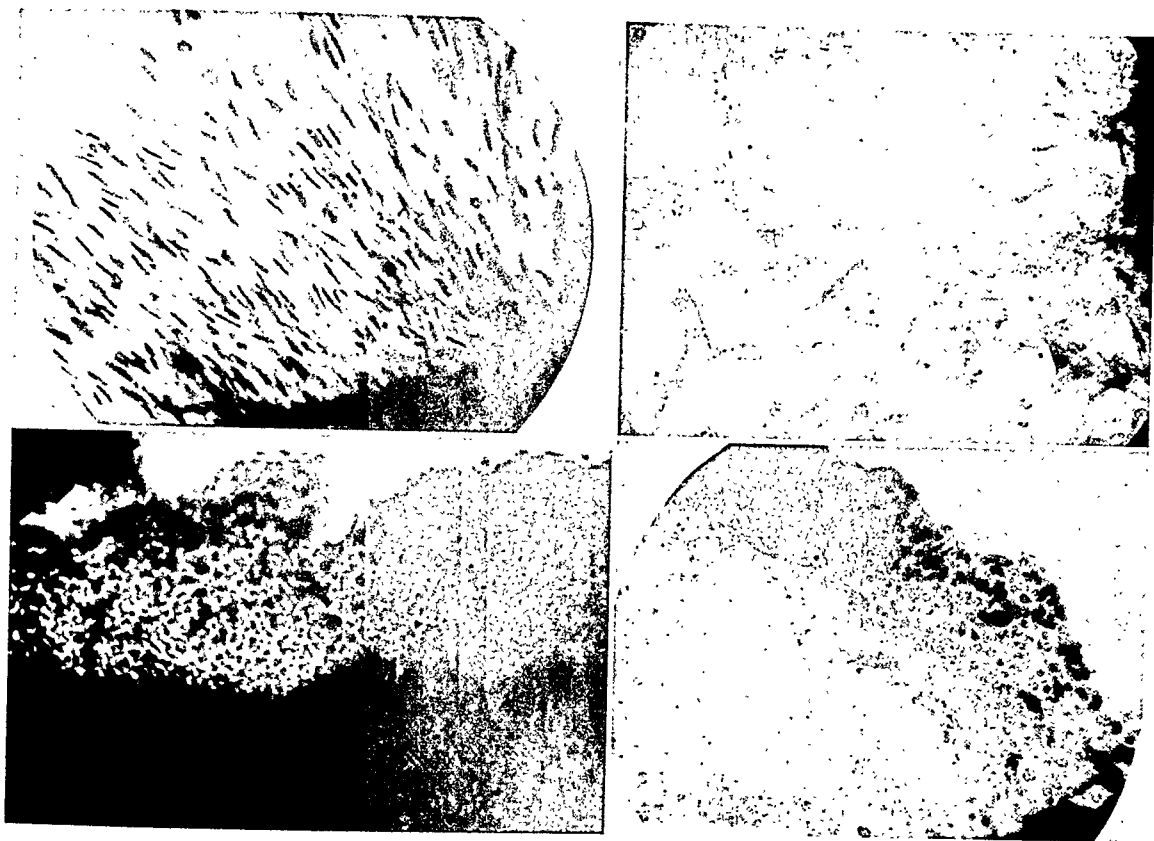


Fig. 5. A culture with an active growth of human myxosarcoma irradiated with 30,000 r and observed 48 hours later. The illustration shows degenerated cells, the nucleus elongated and in some instances broken up and the protoplasm shrivelled. (*Upper left.*)

Fig. 6. A culture of human myxosarcoma as control to Figure 5. Note the different appearance of the cells. (*Upper right.*)

Fig. 7. An explant from the tongue of a 3½-month-old human embryo irradiated with 30,000 r. Note a slight dense growth of epithelial cells which occurred during 48 hours' incubation following irradiation. (*Lower left.*)

Fig. 8. An explant from the kidney of a one-day-old rat irradiated with 30,000 r. Note the small growth of epithelial cells which occurred during 48 hours' incubation following irradiation. (*Lower right.*)

tion of 30,000 r. The offshoots of the fibroblasts were broken up, the protoplasm shrivelled, and the nucleus in many instances elongated or was broken up (karyolysis). The photomicrographs (Figs. 1, 2, 3, 4, 5, and 6) demonstrate the results of this experiment. On the basis of the observations made, it can be concluded that 20,000 r is a sublethal dose for the proliferation of the above-mentioned tissues, while the dose of 30,000 r can be regarded as a lethal dose for explants as well as for actively growing fibroblasts of the same tissues. (It should be mentioned that the total dose of x-rays was administered in a single treatment, not in fractionated doses.)

Different observations were made when cultures of the tongue and kidneys from

human embryos and from kidneys of young rats and mice were exposed to 25,000 and 30,000 r. A slight growth of epithelial cells occurred in some of the cultures during 48 hours' incubation after irradiation, but there was no growth of fibroblasts. (Figures 7 and 8 demonstrate this phenomenon.) The same observations were made on several repeated experiments. While a growth of mixed cells, fibroblasts, and epithelial, occurred in the control cultures (see Fig. 9), only a small growth of epithelial cells took place in the explants which received 25,000 or 30,000 r. When cultures of the kidneys with an active growth of mixed cells, fibroblasts, and epithelial cells were exposed to 30,000 r and watched during 24 hours' incubation

following radiation, the fibroblasts appeared to be degenerated while the epithelial cells apparently seemed not to be dam-

radium elements. As can be seen, some of the radium tubes were placed beneath the culture, but the major part was above the

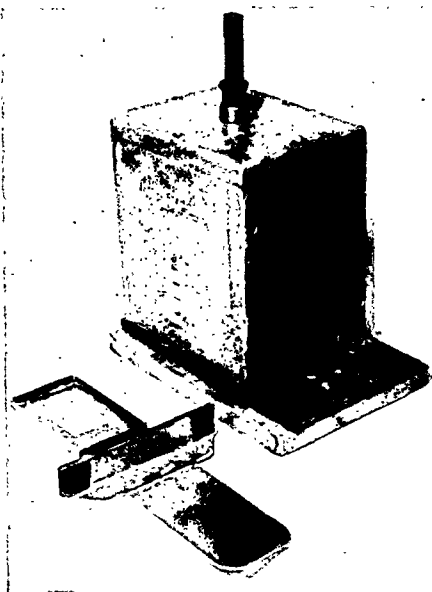


Fig. A. Lead chamber.

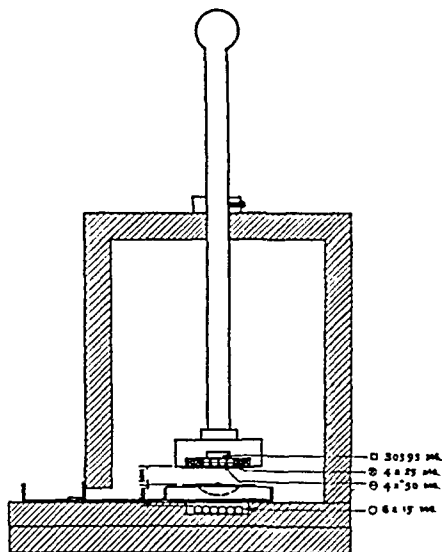


Fig. B. Geometrical arrangement of 693.93 mg. radium.

aged. It can be assumed, therefore, that the fibroblasts are more sensitive to a given dose of radiation than the epithelial cells. Further experiments are in progress in order to reach a more definite conclusion on this point.

#### EXPERIMENT WITH GAMMA RADIATION

For the experiment with radium a lead chamber was constructed as shown in Figure A. The glass slide with the culture was placed on a tray and inserted through the lower opening into the lead chamber (see Fig. A). The radium element consisted of:

4 radium tubes of 50 mg. each = 200	} 0.5 mm. platinum filter 0.5 mm. silver filter
4 radium tubes of 25 mg. each = 100	
6 radium tubes of 15 mg. each = 90	
and a radium capsule of 303.93	

The radium tubes were placed side by side in a holder so that the radiation would be as uniform as possible. Figure B shows the geometrical arrangement of the

culture at 1.0 cm. distance in both instances. Attention should be called to the fact that this experimental set-up was far from ideal. An ideal arrangement would have been to have all the radium element in one capsule. This, however, was not available.

As computed by C. B. Braestrup, our physicist, the radiation from the 693.93 mg. radium element is equivalent at the center of the culture to that from a point source of approximately 270.0 mg. at 1.0 cm. distance and 0.5 mm. platinum filter.

The radiation of the culture took place in an incubator at 37.5° C., separate from the control cultures. Explants were irradiated immediately after they were placed in the culture medium. This was done in order to determine under what amount of radiation the tissue could proliferate. When an effective dose of gamma radiation was determined on explants this dose was later given to cultures with active growth of new cells in order to study its effect on proliferating cells. The amount

of radium element as well as the time of exposure was increased until a lethal dose for explants of the previously mentioned tissues was reached. Only the results obtained with an effective dose of gamma radiation are reported here.

When explants of embryo chick heart and of heart from one- to two-day-old rats were exposed to radiation of 390 mg. radium element (1.0 cm. distance, 0.5 mm. platinum filter), newgrowth of fibroblasts was observed during 18 hours' exposure. This growth, however, was smaller than that of the control cultures. When this culture was left for another 18 hours under radiation, no further growth occurred. The newgrowth from the previous day did not have a healthy appearance, and many fatty droplets were present in the culture, a sign of early degeneration. When explants of the same type of tissue were exposed to radiation of 693.93 mg. radium element for 19 hours, no growth at all from the explant took place. The cultures did not recover, *i.e.*, no growth occurred from the irradiated explants during 48 hours' incubation. In order to find the sublethal dose, explants were exposed to the same amount of radium element for 2, 4, 7, 9, and 13 hours. A good growth of new cells was observed in the cultures which were

irradiated for 2, 4, 7, and 9 hours after 18 hours' incubation. Even the pulsation of the heart fragments could be seen in some of these cultures. Explants exposed to radiation for 13 hours showed a very small

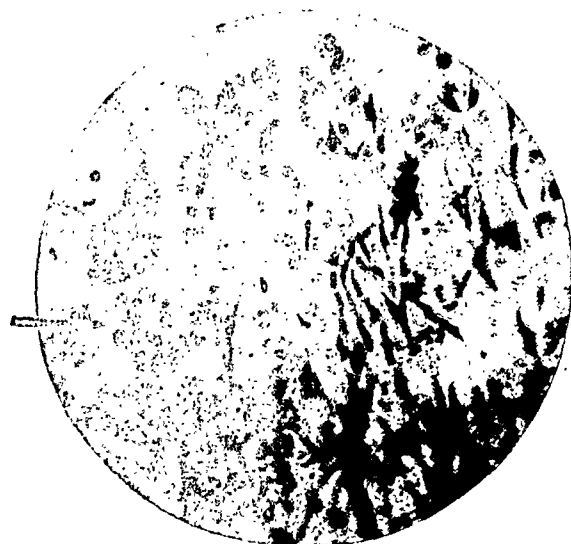


Fig. 9. A culture from the tongue of the same human embryo as that shown in Figure 7. Note a normal growth of mixed cells, epithelial cells, and fibroblasts.

growth of fibroblasts and some outwandering cells were scattered in the field after 48 hours' incubation following irradiation. It was further noted that a culture of embryo chick heart with an active starting growth

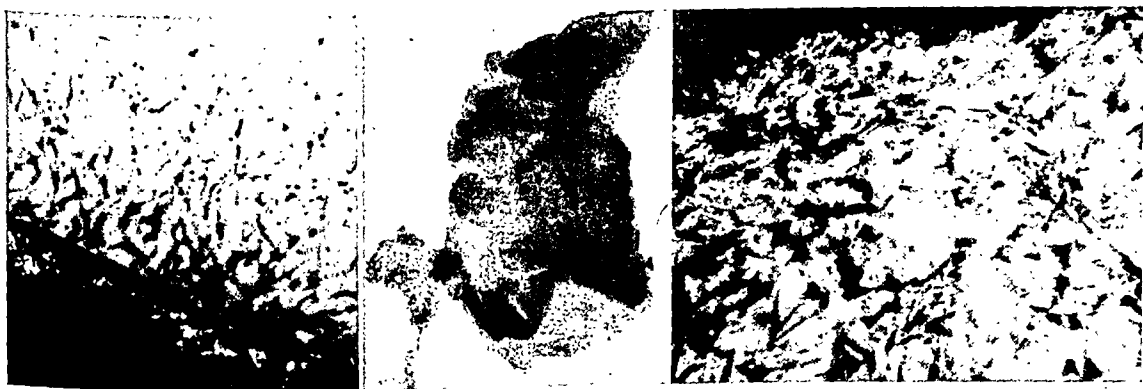


Fig. 10. An explant of embryo chick heart exposed to radiation of 693.93 mg. radium. Note the growth of fibroblasts which occurred during 13 hours' radiation at 37.5° C. This growth was smaller and thinner than that of the control cultures. The culture received 9,022 mg.-hours. (Left.)

Fig. 11. An explant of embryo chick heart exposed to radiation of 693.93 mg. radium during 19 hours. Note that there is no growth or any outwandering cells. Culture received 13,186 mg.-hours. (Center.)

Fig. 12. A culture of rat heart with an active growth of fibroblasts was exposed to radiation of 693.93 mg. radium for 19 hours, receiving 13,186 mg.-hours. Note the destroyed cells. Offshoots of the fibroblasts were broken up, the protoplasm shrivelled, and the nucleus in most instances vacuolated. Observed 48 hours after irradiation. (Right.)

which occurred during seven hours' incubation did not grow further, and the new cells degenerated during 19 hours' exposure to 693.93 mg. radium.

Active growing cultures of embryo chick heart as well as of heart from young rats entirely degenerated while exposed to radiation of 693.93 mg. radium. (The photomicrographs shown in Figures 10, 11, and 12 demonstrate the results of the experiment with radium.)

On the basis of the results obtained with our set-up of 693.93 mg. radium element, we can consider the amount of radiation given during 13 hours, *i.e.*, 9,022 mg.-hr., as the sublethal dose, and the amount of radiation given during 19 hours, *i.e.*, 13,186 mg.-hr., as the lethal dose for explants and active growing fibroblasts of embryo chick heart and of heart from one- to two-day-old rats.

It should be emphasized here how much of a rôle the intensity factor of radiation plays on the effect of living matter. As previously mentioned, explants of embryo chick heart and of heart from very young rats were able to proliferate for a certain period of time while exposed to 390 mg. radium at a distance of 1.0 cm., but no proliferation at all took place during exposure to 693.93 mg. radium element at the same distance at any time.

It was not the aim of this experiment to determine the equivalent roentgen of x-rays for gamma rays. However, the results obtained from our experiments demonstrate the important fact that our equivalent factor of x-rays for gamma rays for chick and mammalian fibroblasts is similar to those factors found by other investigators for other living subjects.

As previously mentioned, the lethal dose of x-rays for chick and mammalian fibroblasts of embryonic origin was reached with 30,000 r, while the lethal dose with gamma rays was obtained with 19 hours of irradiation of 693.93 mg. radium element. This amount of radium element corresponds to 270 mg. at a point source. By multiplying 270 by 19, the lethal dose can be expressed as 5,130 mg.-hours. This

corresponds to the lethal dose obtained with 30,000 r. The equivalent factor of x-rays for gamma rays (r/mg.-hr.) obtained from our experiments is therefore  $\frac{30,000}{5,130} = 5.85$ . This factor lies directly within the range of findings obtained by other investigators, as shown in Table I:

TABLE I

Braun (1930)	<i>Ascaris</i> eggs	killing	5.3
Holthusen and Hamann (1932)	skin	erythema	5.3
Neeff (1934)	skin	erythema	5.7-6.3
Exner and Packard (1935)	<i>Drosophila</i> eggs	killing	5.0
Henshaw and Francis (1936)	<i>Drosophila</i> eggs	killing	5.4

Our equivalent factor for chick and mammalian fibroblasts is 5.8.

Attention should be called to the fact that a gap has to be filled in our experiments, *i.e.*, to determine the effective doses of gamma radiation between 13 and 19 hours as well as of x-rays between 25,000 r and 30,000 r. It is possible that the lethal dose for the tissues used in our experiments could be reached with 16, 17, or 18 hours' gamma radiation with our radium set-up as well as with 26,000, 27,000, or 29,000 r. This, however, will not change the factor materially. Since the radium capsule of 303.93 mg. was available for only a limited period of time, this experiment could not be completed before this limited time expired.<sup>2</sup> We hope to be able to continue this experiment in greater detail in the near future.

#### EXPERIMENT WITH UNFILTERED RADON BULBS

Cultures of embryo chick heart, heart and kidneys from one- to two-day-old rats were used for this experiment, the major

<sup>2</sup> We wish to express our thanks to the Radium Chemical Company for their loan of the radium capsule.

part of the work being carried out with explants of the above-mentioned tissues. In some instances cultures with 24- or 48-

especially in the periphery of the margin of the newgrowth, looked unhealthy, and many fat droplets were present.

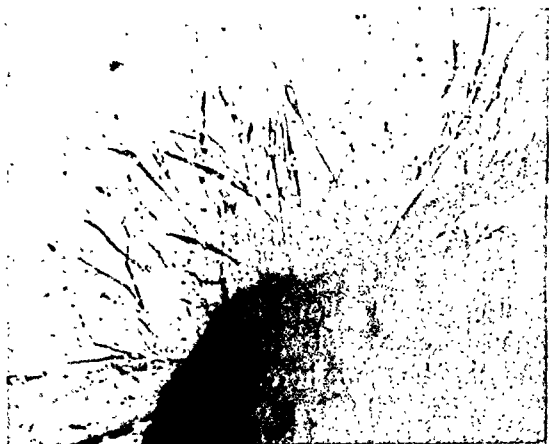


Fig. 13. An explant of embryo chick heart exposed to an unfiltered radon bulb containing 71.13 millicuries for 23 hours and 30 minutes at 0.5 cm. distance. A new growth occurred under radiation, but the newgrowth was smaller and thinner than that of the control cultures. The cells did not have a healthy appearance; many were vacuolated. Culture received 1,541 millicurie-hours. (Left.)



Fig. 14. An explant of embryo chick heart exposed to radiation of 102.1 millicuries unfiltered radon bulb at 0.5 cm. distance for 23 hours and 30 minutes. Note absence of growth and outwandering cells. Culture received 2,200 mc.-hours. (Right.)

hour active growth of new cells were used. The cultures were irradiated in the same lead chamber (Fig. A) as used for the previous experiment, with radium at  $37.5^{\circ}\text{C}$ . and 0.5 cm. distance from the unfiltered radon bulb. As a rule we have started with small amounts of radon, increasing the dose until a definite effect upon tissue growth *in vitro* was reached.

The experiment was started with an unfiltered radon bulb containing 27.6 millicuries. Explants of 8-day-old embryo chick heart were irradiated for one hour and 15 minutes, receiving 34.5 millicurie-hours, and others for three hours, receiving 82.8 millicurie-hours. Growth occurred in the irradiated explants following 24 hours' incubation, showing that there was no apparent difference in comparison with the newgrowth of the control cultures. A culture with 24-hour growth *in vitro* was put under radiation of an unfiltered radon bulb containing 26.77 millicuries for 24 hours. This culture received 585.6 millicurie-hours of gamma and beta radiation. The growth of the culture increased in size during radiation. The new cells, however,

For the next experiment an unfiltered radon bulb consisting of 59.7 millicuries was used. An explant of embryo chick heart irradiated for three hours and 20 minutes, receiving 191 millicurie-hours, showed a good growth following 24 hours' incubation. Another explant of embryo chick heart produced new growing cells during 16 hours' exposure to an unfiltered radon bulb of 56.85 millicuries, receiving 858 millicurie-hours. The newgrowth, however, was much thinner and smaller in this culture than that of the control cultures and many cells were vacuolated.

In our further experiments—which were rather extensive—we have found that explants of embryo chick heart exposed to an unfiltered radon bulb containing 102.1 millicuries at 0.5 cm. distance did not show any newgrowth or outwandering cells during 23 hours and 30 minutes' radiation, receiving 2,200.0 millicurie-hours. The culture did not recover, *i.e.*, no growth occurred in this irradiated culture following 48 hours' incubation at  $37.5^{\circ}\text{C}$ . While another explant of embryo chick heart exposed to an unfiltered bulb containing 71.1



millicuries radon at 0.5 cm. distance for 23 hours and 30 minutes, receiving 1,541 millicurie-hours, showed a small, thin growth of new cells, and some outwandering cells were scattered in the field. Since these two radon bulbs did not differ widely in the amounts of radon and the explants were exposed for the same time, it seems to us that the lethal dose for chick embryonic fibroblast lies between 1,532.0 and 2,200.0 millicurie-hours. The dose of 1,532.0 millicurie-hours can be regarded as a sublethal one. Similar observations were made when explants of the heart from young rats were exposed to the same amount of radiation. Figures 13 and 14 demonstrate this experiment.

Summarizing, the results obtained in our experiment for the sublethal and lethal doses for chick and mammalian fibroblasts are described in Table II.

The results obtained in these experiments should be considered only for these

TABLE II

Sources of Radiation	Sublethal Dose	Lethal Dose
X-rays	20,000 r	25,000-30,000 r
Gamma Rays	9,022 mg.-hr.	13,186 mg.-hr.
Radon (unfiltered)	1,532 mc.-hr.	2,200 mc.-hr.

types of tissues, as mentioned in the text under the circumstances described above.

#### THE EFFECT OF UNFILTERED RADON ON CELL RESPIRATION *in vitro*

In regard to the effect of irradiation on cell respiration *in vitro*, a brief report will be made here.

Kidneys of three- to four-month-old mice irradiated with doses ranging from 3,000 to 6,000 millicurie-hours unfiltered radon showed a decrease in oxygen uptake between 30 and 50 per cent. A more detailed report on this subject will be given in a separate article.

# THE EFFECT OF RADIATION ON CELL RESPIRATION

## I. RESPIRATION AND ANÆROBIC GLYCOLYSIS OF MOUSE KIDNEY *IN VITRO* FOLLOWING RADIATION<sup>1</sup>

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THE purpose of this experiment was to correlate the effect of various types of radiation on the growth and respiration of mammalian tissues *in vitro*. The results of the effect of x-rays, radium, and radon upon growth *in vitro* are recorded in a separate paper. We were able to determine the lethal dose and sublethal dose of these three types of radiation for tissues of various origin grown *in vitro*. As in the experiments on proliferation, we have also attempted to determine the effective dose of radiation for respiration.

### MATERIAL AND EXPERIMENTAL PROCEDURE

In a previous communication (1) we reported the values of O<sub>2</sub> uptake and the respiratory quotients of normal mouse kidneys which showed the most uniform respiration. This type of tissue was, therefore, selected for the experiment with radiation. The kidneys removed under aseptic precautions from three- to four-month-old mice, immediately after pitting, were placed in hollow ground Maximov's slides, a small strip of moist filter paper was placed beside the kidneys in order to avoid evaporation, then covered with a sheet of mica sealed with paraffin wax and exposed to radiation. The reason for using Maximov's slides was because the same equipment was used here as for radiation of the tissue cultures. Since a marked decrease in respiration of normal kidneys was observed when they were kept at room or body temperature for several hours and a very slight decrease in res-

piration when they were kept at 4° C., the radiation, therefore, was administered at 4° C. While one kidney was exposed to radiation at about 4° C., the other was kept in the refrigerator as a control. After a certain dose of radiation was administered, the kidneys were immediately prepared for respiration *in vitro*. A Ringer-phosphate solution containing 0.2 per cent glucose and at pH 7.4 was used as a nutritive medium. The respiratory exchanges of the tissue were determined by the use of the Barcroft-Warburg manometric apparatus. An improvement in this apparatus which we have found increases the precision of the measurements and saves more than one hour will be briefly described here. The Barcroft-Warburg apparatus consists of 14 vessel manometers which are normally used for each experiment. For the determination of respiratory exchanges of tissues, each vessel manometer is saturated for several minutes with a gas (with O<sub>2</sub> for aerobic and N<sub>2</sub> for anærobic glycolysis). The improvement consists of cross-shaped glass tubes which are connected to each other and to the manometers with rubber tubing. The flow of gas to each vessel manometer is regulated with a screw clamp. When these clamps are once regulated so that the pressure in all vessel manometers is uniform, they need no further attention in the subsequent experiments. Before each experiment the glass tubes are attached to the vessel manometers, the whole system is connected with a gas-tank, and the saturation with gas takes only a few minutes. Figure 1 shows the whole system

<sup>1</sup> See Figures A and B in Dr. Goldfeder's paper on page 76 of this issue.

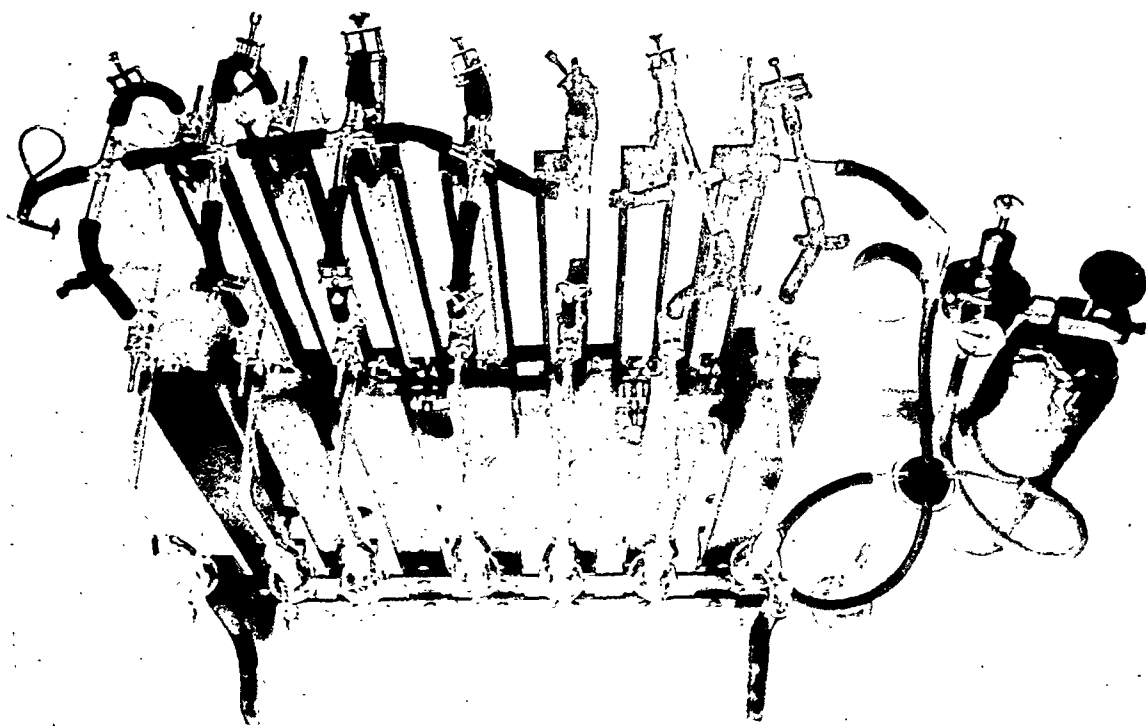


Fig. 1.

and Figure 2 shows the cross-shaped glass tube. Since this technical improvement not only increases the accuracy of the results because the tissue is kept about an hour less at the room temperature before

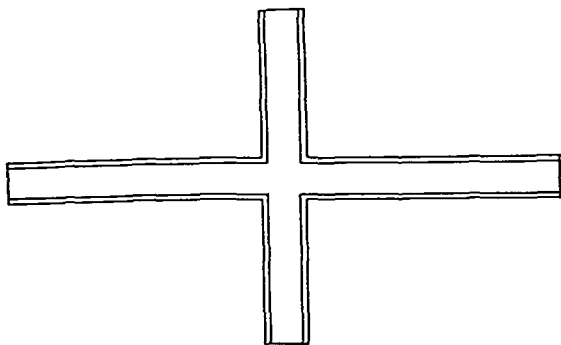


Fig. 2.

the real experiment starts, but also saves so much time for the research worker that we think it is worth while to mention it here and to recommend it to other workers in this field.

Before each experiment the water bath is regulated to  $37.5^{\circ}\text{C.}$ , the whole apparatus is set up, the Ringer-phosphate solution placed in the vessels shortly before the radiation of the tissue is completed, the tissues (both control and radiated) are minced or sliced with a very sharp razor, and samples, weighed out on a torsion balance, are placed in the vessels containing the nutritive medium, which are subsequently attached to the manometers. The whole system is then saturated with gas so that no more than from 20 to 30 minutes elapse from the time that the radiation was discontinued until the respiration of the tissues, both irradiated and control, starts in the vessel manometers at body temperature.

#### EXPERIMENT WITH X-RAYS

A half wave tube generator and a thin-walled Coolidge tube were used as the source of x-rays. The kidneys were irradiated at a focal distance of 40 cm., using 200 kv., 6 ma., with 1 mm. alumi-

num filter (effective wave length  $0.32 \text{ \AA}$ ). Under these conditions, the average intensity was  $80.75 \text{ r/min.}$  measured in air. For each experiment a pair of kidneys was used. Each kidney, removed from the mouse immediately after pitting, was sealed in a separate Maximov slide as previously described. One slide containing the kidney was immediately placed in a wooden frame above ice cold water and exposed to radiation; the other was placed in a refrigerator. In this way the temperature of both kidneys was kept between  $4^\circ$  and  $5^\circ \text{ C.}$  Since the kidneys were kept above water during radiation, 35 per cent of back-scattering was taken into consideration in calculating the total dose. It should be mentioned that the doses of x-rays were administered at once, not fractionated. The first experiment was carried out with 1,800 r. Since no appreciable difference could be observed in the  $\text{O}_2$  uptake and the respiratory quotients of the irradiated kidney in comparison with that of the control, the further experiments were carried out with increasing doses of x-rays up to 30,000 r. No marked effect was noted on the respiratory exchanges of the irradiated kidneys within the range of the administered dose, from 1,800 to 30,000 r, inclusive. As an example, the results of three experiments are recorded in Table I. No marked difference can be observed between the values of  $\text{O}_2$  uptake and respiratory quotients of the irradiated and control kidneys. In order to reach larger doses of

radiation a longer time of exposure or different equipment for the source of x-rays would be necessary. Due to the lack of technical facilities, it was impossible to continue these experiments at present. However, the following interpretation of the results obtained thus far can be made.

Some investigators observed an increase in the  $\text{O}_2$  uptake of tissues which had been irradiated with small doses of x-rays; others, however, noted a decrease. For instance, Heeren and Pansdorf (2) observed an increase of 25 per cent in  $\text{O}_2$  uptake of the irradiated mouse kidney investigated immediately after irradiation. Dognon (3) claims from his experiments with irradiated kidneys of guinea pigs that a decrease in  $\text{O}_2$  uptake occurs following irradiation with 1,000 r.

In accordance with our observations, no such conclusions can be drawn. Neither a decrease nor an increase was observed in the  $\text{O}_2$  uptake and respiratory quotient of the mouse kidney following irradiation with from 1,800 r to 30,000 r, inclusive, in our experiments. The results of the effect of x-rays on growth of various tissues were reported in a separate article. (See foregoing paper by A. G.) We were able to demonstrate that fragments of kidneys from one- to two-day-old mice or rats irradiated with 30,000 r showed only a slight growth of epithelial cells during two to three days' incubation at  $37.5^\circ \text{ C.}$  following irradiation, while control cultures showed an abundant growth of new cells. Since kidneys of three- to four-

TABLE I.—OXYGEN CONSUMPTION AND RESPIRATORY QUOTIENTS OF MOUSE KIDNEY IRRADIATED AT  $4^\circ \text{ C.}$  WITH X-RAYS *IN VITRO* IN 0.2 PER CENT DEXTROSE RINGER-PHOSPHATE SOLUTION BUFFERED TO pH 7.4 AT  $37.5^\circ \text{ C.}$

(For each experiment, 12 to 14 vessels were used and the average results are recorded)

No. of Experiment	Dose in r	Respiration			R.Q.	Respiration of Control Kidneys			R.Q.
		$\text{QO}_2$ in first hr.	$\text{QO}_2$ in second hr.	Total $\text{QO}_2$ in two hr.		$\text{QO}_2$ in first hr.	$\text{QO}_2$ in second hr.	Total $\text{QO}_2$ in two hr.	
1	1,800	3.41	3.09	6.50	0.85	3.65	3.50	7.15	0.88
2	6,000	3.5	3.6	7.1	0.84	3.19	3.12	6.31	0.80
3	30,000	3.20	2.94	6.14	0.81	2.83	3.05	5.88	0.91

month-old mice irradiated with 30,000 r showed a normal respiration, while kidneys of one- to two-day-old mice irradiated with 30,000 r showed only a slight growth, the question, therefore, arises: Is a higher dose of irradiation necessary in order to affect respiration than is necessary for checking proliferation or is adult tissue more resistant to a given dose of x-rays than that of embryonic origin? We hope to answer this question by further experiments.

#### EXPERIMENT WITH RADIUM

The same procedure and technic as used for the experiments with x-rays were applied here, *i.e.*, the kidneys removed immediately after pitting from normal mice were placed in separate Maximov slides, covered with mica sheets and sealed with paraffin wax. One slide, containing the kidneys, was exposed to radiation; the other kept for control. A lead chamber was used here as has been used for the experiment with tissue cultures (Fig. A). Figure B illustrates the geometrical arrangement of the radium elements. The tissues were irradiated at a distance of 1 cm. The first two experiments were carried out with 300 mg. radium. The kidneys were irradiated in the incubator at 37.5° C. In the first experiment the kidney was exposed for one hour and 25 minutes, receiving 375 mg.-hr.; in the

other experiment for two hours, receiving 600 mg.-hr. The control kidneys were kept in a separate incubator at 37.5° C., while the others were irradiated. The results obtained in the experiment with radium are recorded in Table II. As can be seen from Experiments No. 1 and No. 2, no marked difference in oxygen uptake of the irradiated and control kidneys occurred, but a low respiration of both kidneys was noted, due to the temperature.

On the basis of these observations that kidneys kept for longer periods of time at 37.5° C. show a decrease in O<sub>2</sub> uptake, while those kept in the icebox for 24 hours show only a slight decrease in O<sub>2</sub> uptake, the radiation of the kidney tissue in our further experiments was, therefore, administered in an icebox at 4° C. Kidneys irradiated with 300 mg. radium, for four hours at 4° C., receiving 1,200 mg.-hr., showed no marked difference in oxygen uptake from the control kidneys. (See Experiment No. 3, Table II.)

Since no marked change in O<sub>2</sub> uptake was observed by using the amounts of irradiation mentioned above, the amount of radium element was increased in order to increase the dose and to avoid a longer time of exposure. Experiments No. 4 and No. 5 were carried out with 390 mg. radium, to which, in Experiment No. 4, the kidney was exposed for four hours, receiving 1,560

TABLE II.—OXYGEN CONSUMPTION AND RESPIRATORY QUOTIENTS OF MOUSE KIDNEY RADIATED WITH RADIUM AT 4° C. *IN VITRO* IN 0.2 PER CENT DEXTROSE RINGER-PHOSPHATE SOLUTION BUFFERED TO pH 7.4 AT 37.5° C.

(For each experiment, 12 to 14 vessels were used and the average results are recorded)

No. of Experiment	Dose in Mg.-hr.	Respiration			R.Q.	Respiration of Normal Control Kidneys			R.Q.	Remarks
		Q <sub>O<sub>2</sub></sub> in first hr.	Q <sub>O<sub>2</sub></sub> in second hr.	Total Q <sub>O<sub>2</sub></sub> in two hr.		Q <sub>O<sub>2</sub></sub> in first hr.	Q <sub>O<sub>2</sub></sub> in second hr.	Total Q <sub>O<sub>2</sub></sub> in two hr.		
1	375	1.01	0.77	1.8		1.09	1.1	2.1		The calculations were made on wet weight of the kidney tissue. In Experiments No. 1 and No. 2 the kidneys were irradiated at 37.5° C.
2	600	0.18	0.66	1.44		1.1	0.8	1.1		
3	1,200	3.71	2.93	6.76		3.76	3.8	7.92		
4	1,560	2.3	2.4	4.6	0.94	3.8	3.8	7.6	0.84	
5	1,657	2.3	2.5	4.51	0.86	2.6	2.5	5.1	0.89	
6	3,470	3.3	3.4	6.3	0.89	3.4	2.8	6.2	0.85	
7	4,164	2.5	2.3	4.8	0.86	2.7	2.6	5.3	0.86	

mg.-hr., and in Experiment No. 5 the kidney was exposed for four hours and 15 minutes, receiving 1,657 mg.-hr.

No marked change in oxygen uptake and respiratory quotient occurred in the irradiated kidney in comparison with that of the control kidney. Experiments No. 6 and No. 7 were carried out with 693.93 mg. radium.

In Experiment No. 6 the kidney was irradiated for five hours at  $4^{\circ}\text{C}$ ., receiving 3,470 mg.-hr., and in Experiment No. 7 for six hours, receiving 4,164 mg.-hr. No marked difference either in oxygen uptake or in the respiratory quotients could be observed in either experiment when compared with that of the control kidneys. It should be mentioned here that the tissue received only gamma radiation from our radium set-up. As computed by C. B. Braestrup, our physicist, the radiation from the 693.93 mg. radium element is equivalent, at the center of the culture, to that from a point source of approximately 270 mg. at 1.0 cm. distance and 0.5 mm. platinum filter.

Due to the limited time of the loan of radium from the Radium Chemical Company, in New York City, the experiment with radium had to be discontinued for the present.

Comparing the results obtained from the effect of gamma irradiation upon proliferation, it can be seen that the amount of irradiation which apparently did not affect the proliferation also did not affect the respiration. However, there was a difference in the temperature at which the tissues were kept while being exposed to irradiation. The proliferating tissues were irradiated at  $37.5^{\circ}\text{C}$ ., while the tissues used for respiration were exposed to irradiation at  $4^{\circ}\text{C}$ .

Halberstädter and Doljanski (4), in a recently published article, reported results which they observed of the effect of irradiation with radium on explants of chick embryos. They reached the conclusion that tissue fragments exposed to irradiation *in vitro* at a low temperature accumulate more radium than while in a stage of

proliferation at  $37.5^{\circ}\text{C}$ . They were able to prevent emigration and proliferation of cells from the irradiated fragments *in vitro* at a low temperature with much smaller doses than are required to obtain the same effect while these fragments are exposed at body temperature.

Although the amount of radiation administered by us to the mouse kidney at a low temperature was much higher than that used by the above mentioned authors, yet no effect on respiration could be observed. However, in discussing this phenomenon two possibilities have to be taken into consideration: (1) Halberstädter and Doljanski have used chick embryonic tissue for their experiments, while we have used mammalian adult tissue; (2) with their set-up of radium element the tissues received a certain amount of beta rays which are more effective than gamma rays, while with our set-up only gamma rays can be considered. Another possibility is that a larger dose of irradiation is necessary to affect the metabolism of cells than is required to check their proliferation.

From further experiments which we have in progress, we hope to be able to throw more light on this problem.

#### EXPERIMENT WITH UNFILTERED RADON BULBS

As previously mentioned, various experiments were carried out with x-rays and radium on the effect of respiration of living matter. However, no data could be found in the literature concerning the effect of radon (gamma plus beta rays) on cell respiration and glycolysis *in vitro*. Since no definite results could be reached on the effect of radiation on cell respiration *in vitro* by means of x-rays and radium with our set-up, a series of experiments were undertaken with the use of unfiltered radon bulbs. The same type of tissue, *i.e.*, the kidneys of three- to four-month-old mice, was exposed in Maximov slides immediately after removal from the animal body, to various amounts of beta plus gamma radiation. The kidneys were irradiated in the same lead chamber (Fig. A) as used

TABLE III.—OXYGEN CONSUMPTION AND RESPIRATORY QUOTIENTS OF MOUSE KIDNEY IRRADIATED AT 4° C. WITH UNFILTERED RADON *IN VITRO* IN 0.2 PER CENT DEXTROSE RINGER-PHOSPHATE SOLUTION BUFFERED TO pH 7.4 AT 37.5° C.

(For each experiment, 12 to 14 vessels were used and the average results are recorded)

No. of Experiment	Dose in Mc.-hr.	Respiration			R.Q.	Respiration of Normal Control Kidneys			R. Q.	Decrease in O <sub>2</sub> of Irradiated Kidneys in Percentage	Remarks
		Q <sub>O<sub>2</sub></sub> in first hr.	Q <sub>O<sub>2</sub></sub> in second hr.	Total Q <sub>O<sub>2</sub></sub> in two hr.		Q <sub>O<sub>2</sub></sub> in first hr.	Q <sub>O<sub>2</sub></sub> in second hr.	Total Q <sub>O<sub>2</sub></sub> in two hr.			
1	1,180	1.84	1.38	3.22	0.9	2.7	2.5	5.2	0.85	36	The decrease in respiration of the irradiated kidneys is more marked in the second hour of respiration.
2	3,936	1.32	0.66	1.98	0.87	2.3	2.0	4.4	0.84	50	
3	3,334	1.72	1.0	2.72	0.84	2.1	2.1	4.2	0.92	45	
4	6,710	1.47	0.74	2.21	0.82	3.2	2.8	6.1	0.83	64	
5	6,546	1.54	0.76	2.16	0.81	2.5	2.3	4.8	0.89	56	
6	5,118	1.60	0.84	2.44	0.78	1.9	2.1	4.0	0.89	40	
7	3,822	2.48	1.66	4.14	0.83	3.1	2.6	5.7	0.84	30	

for the experiment with radium, at a temperature of 4° C. at 0.5 cm. distance.

As usual, while one kidney of the mouse was irradiated, the other was kept in a moist and sealed Maximov slide in a separate icebox. In order to reach an effective dose, high doses of irradiation were necessary. For this reason, in most instances, the kidneys were left over night in the iceboxes. As previously mentioned, only a slight decrease in respiration occurred in normal kidneys when kept over night in the icebox, whereas when kept at room temperature or at 37.5° C. a much greater fall in metabolism occurred.

In Table III are recorded the values of O<sub>2</sub> uptake and respiratory quotients of both irradiated and normal kidneys from each mouse. As can be seen from the data, a marked decrease in the oxygen uptake occurred in the irradiated kidneys, but no marked change in the respiratory quotients was observed when compared with the corresponding values of the control kidneys. A rapid fall in respiration particularly occurred during the second hour of respiration *in vitro*.

This phenomenon was also observed by Dognon, *l.c.*, in his experiments with a dose of 20,000,000 r. The decrease in O<sub>2</sub> uptake of the irradiated kidneys corresponds to the increase of the dose administered with one exception. In Experiment No. 3 the kidney received 3,334 mc.-hours which produced a reduction in O<sub>2</sub> uptake of 45 per cent, while in Experiment No. 7, when the kidney received 3,822 mc.-hours the decrease in O<sub>2</sub> uptake was only 30 per cent. This may have been an artefact.

Several experiments were carried out to observe the effect of unfiltered radon on anaerobic glycolysis. The same experimental procedure was used here as for the previous experiments with the exception that the vessel manometers containing the tissue were saturated with a gas mixture of 95 per cent N<sub>2</sub> and 5 per cent CO<sub>2</sub> and a bicarbonate Ringer solution, as originally advised by Warburg for anaerobic glycolysis, was also used here. Since the CO<sub>2</sub> evolved as indicated

by the pressure in the manometers does not correspond specifically to the amount of lactic acid formed by the tissue, particularly of kidneys, because of the presence of a certain amount of ammonia, the amount of lactic acid formed by the tissues, irradiated and control, during two hours was determined in the medium by the chemical method of Friedemann-Graeser (5). We have followed this method precisely as recommended by the authors; no description, therefore, will be given here.

In Table IV are recorded the results obtained from the effect of unfiltered radon on anærobic glycolysis. As can be seen from these results, the decrease in anærobic glycolysis increases with the dose of radon administered to the tissue but not in as narrow a range as was observed in the experiments on respiration. Comparing the results recorded in Table III and Table IV, the following facts are apparent: (1) The percentage of decrease in oxygen uptake corresponds directly with the increase in the amount of radiation administered within a narrow range, while in the anærobic glycolysis this is not the case. For example, Experiment No. 3 (Table IV) received 6,736 mc.-hr. and showed a decrease of 83 per cent in the amount of lactic acid as compared with that of the normal kidneys, while Experiment No. 5 which received 7,727 mc.-hr. showed a decrease of only 84 per cent, although the dose exceeded the former by about 1,000

mc.-hours. On the other hand, we see an agreement between the results of the Experiments No. 3 and No. 4 in which doses of radon are approximately the same. (2) Approximately the same dose of radon produced a greater decrease in anærobic glycolysis than in respiration, as can be seen from Experiment No. 4 in Table III and from Experiment No. 3 in Table IV.

#### SUMMARY AND CONCLUSION

A study was undertaken to investigate the effect of various types of radiation on growth and respiration *in vitro* of mammalian tissues. The effect upon growth of various tissues was reported in a separate article. The results obtained thus far on the effect of respiration and anærobic glycolysis are being reported here. As an index, the normal mouse kidneys were used for this experiment. The types of radiation employed were high voltage x-rays, gamma rays from radium, and radon (gamma plus beta rays). For the determination of the oxygen uptake and respiratory quotients the Warburg manometric apparatus was used. Friedemann-Graeser's method was used for the determination of lactic acid. The kidneys were irradiated *in vitro* at 4° C. No appreciable effect on respiration and on the respiratory quotients could be observed with the arrangement of radium and x-rays as used by us thus far. For example, with 4,140 mg.-hr. of gamma radiation and 30,000 r units of x-rays, no effect on kidney

TABLE IV.—ANÆROBIC GLYCOLYSIS OF MOUSE KIDNEY IRRADIATED AT 4° C. WITH UNFILTERED RADON *IN VITRO* IN 0.2 PER CENT DEXTROSE BICARBONATE RINGER SOLUTION BUFFERED TO pH 7.4 AT 37.5° C.

Irradiated Kidneys			Control Kidney Mg. Lactic Acid per Mg. Tissue 2 Hr.	Decrease in Lactic Acid of Irradiated Kidneys in Per- centage
No. of Experiment	Dose in Mc.-hr.	Mg. Lactic Acid per 1 Mg. Tissue 2 Hr.		
1	1,949	0.00387	0.00748	48
2	3,050	0.00220	0.0065	65
3	6,736	0.00090	0.0053	83
4	6,720	0.00266	0.01682	84
5	7,727	0.00067	0.00431	84



respiration of adult mice was obtained. A definite effect on respiration and anaerobic glycolysis was observed when the kidneys were irradiated with unfiltered radon. With doses ranging from 4,000 to 6,500 mc.-hr. of gamma plus beta radiation a decrease in  $O_2$  uptake between 40 and 60 per cent was observed, without any effect, however, on the respiratory quotients, while doses ranging from about 2,000 to 7,700 mc.-hr. produced a decrease in anaerobic glycolysis ranging between 50 and 84 per cent.

As can be concluded from this experiment, a high dose of irradiation is necessary to produce an effect on respiration of living matter—in this case of adult mouse kidneys—and a still higher dose to affect the respiratory quotient. In other words, the respiration of the living cells can be affected without producing a marked change in the respiratory quotient. This observation contradicts the hypothesis of H. Rudisill and J. H. Hoch<sup>2</sup> that the biological effect of irradiation on cells may result from the effects of the substances, so-called co-catalysts present in the cells.

Another point which should be emphasized here is as follows: Many investigators believe in a delayed effect of radiation on living processes, *i.e.*, that the effect of various rays is not a direct but rather a delayed one, produced by secondary changes in the living matter. The results obtained by us in the experiment with radon indicate that the effective dose of radiation on living processes depends on the action of the specific rays and the dose administered. From our experiments it can be seen how much more effective the beta rays are than the x-rays or gamma rays alone and how through the beta rays a direct effect on cell respiration and anaerobic glycolysis can be obtained. With a dose of 30,000 r and with a dose of 4,164 mg.-hr. of gamma rays alone, no effect on respiration and respiratory quotient was observed, while a corresponding dose of 3,936 mc.-hr. of beta plus gamma rays pro-

duced a decrease in respiration of 50 per cent.

Comparing the effect of unfiltered radon on proliferation and respiration the following observations were made. A dose of 2,200 mc.-hr. of unfiltered radon administered to an explant of a kidney from one-day-old rats or mice entirely inhibited the proliferation of this explant, while a dose of 6,710 mc.-hr. administered to a kidney from about a four-month-old mouse produced a reduction of only 64 per cent in  $O_2$  uptake. The question arises whether a higher dose is necessary to inhibit the proliferation of the cells than their respiration, or is adult tissue more resistant to a given dose of radiation? Through further experimentation, using tissues of embryonic and other origin which are in progress at present, we hope to be able to answer this question and to throw more light on the effect of various rays on living processes.

Our grateful thanks are herewith expressed to Ira I. Kaplan, M.D., and to Frank CoTui, M.D., for their kind cooperation and interest in making this work possible. We also are indebted to Carl B. Braestrup, physicist for the Division of Cancer, Department of Hospitals, City of New York, and his associates for their helpful advice and assistance, and we wish to thank the Works Progress Administration for the loan of the Warburg manometric apparatus used for these experiments and Warner, Schering, and Glatz, Inc., for financial aid.

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<sup>2</sup> A paper presented at the Fifth International Congress of Radiology, September, 1937.

# GENERATORS FOR GAMMA RAYS AND NEUTRONS AND RADIOTHERAPEUTIC POSSIBILITIES<sup>1</sup>

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THE technic of high voltage generators and high voltage discharge tubes for the production of penetrating x-rays has been successfully applied to nuclear physics. In fact, generators for one million volts and more, designed to produce x-rays by accelerating electrons (the usual

the gas in the discharge tube is hydrogen, deutons in the case of heavy hydrogen, and  $\alpha$ -particles in the case of helium).

The acceleration of the positive particles takes place in a tube which shows, as we shall see in more detail later on, a great analogy with a high voltage x-ray tube.

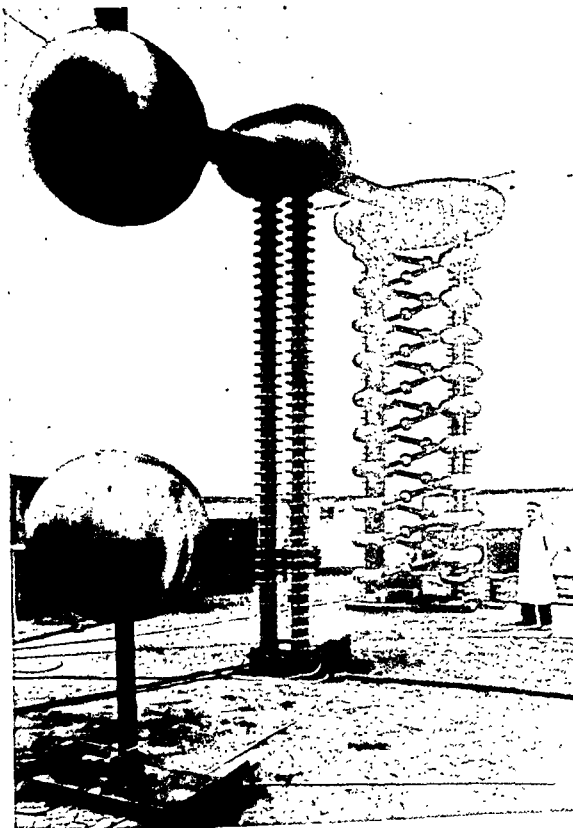


Fig. 1.

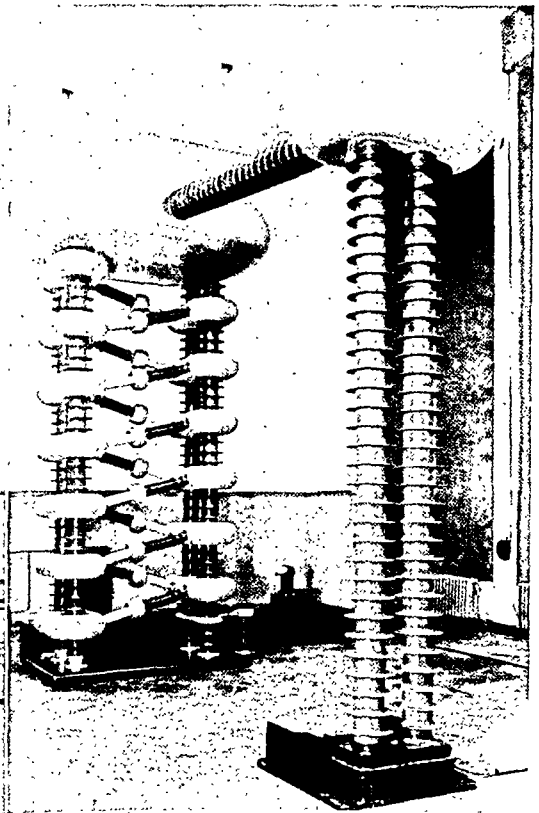


Fig. 2.

way), can be used to accelerate positive particles merely by reversing the tension.

Positive particles may be produced by voltages of the order of 50 kv. in tubes not essentially different from the good old gas tubes, the positive ions emerging through a hole in the cathode. These positive ions (canal rays) are protons if

At the other hand, the results of nuclear physics have stimulated further development of high voltage technic. Generators for voltages of many millions of volts have been designed. The first interesting nuclear reaction by means of high voltage was performed by Cockcroft and Walton in 1932 (1). The lithium nucleus was split up into two helium nuclei or  $\alpha$ -particles by means of protons accelerated with

<sup>1</sup> Read before the Fifth International Congress of Radiology, at Chicago, September, 1937.

a voltage of some hundreds of kilovolts. It was shown later that this reaction is possible with voltages as low as 10 kv. (2, 3); but the output increases rapidly with the voltage, as is the case for most nuclear reactions. Moreover, many reactions cannot be expected to take place below certain minimum voltages. So, for instance, may a beryllium nucleus be split up by x-rays or  $\gamma$ -rays equivalent to one and a half million volts as a minimum value. At voltages of little over one million volts (1 mv.) a very interesting phenomenon appears: a gamma quantum is transformed into a pair of particles, a positron and an electron. The production of x-rays ( $\gamma$ -rays) of one million volts becomes extremely efficient, the output at one million volts being equivalent to more than 1 kg. of radium at 1 ma. tube current.

A short description of a high voltage generator developed by the author, given at the American Congress of Radiology in 1933, has been published (4). This generator has been further developed up to a voltage of four mil-

lion volts. A full description has been published recently (5). The article contains also a brief critical survey of the other methods to produce fast particles with and without high voltages.

Figure 1 shows a generator of two million volts to earth, being the negative half of a four-million-volts set at the Eindhoven laboratories.

Figure 2 shows a one and a quarter million volts generator delivered to, and in use for many months now at, the Cavendish Laboratory, Cambridge. For further details we refer to the paper mentioned above (4) and proceed to describe—(a) A million-volt x-ray or  $\gamma$ -ray tube of the sealed-off type; (b) A high voltage neutron tube.

(a.) A sealed-off tube for tensions up to 700 kv. was reported upon by Dr. van der Tuuk and myself (6).

Figure 3 shows the construction of the one-million-volt tube comprising three sections. Electrons are produced by the cathode, C, of the first section, and accelerated to a speed of over 330 kv. in the first division (1). The electrons entering the second section with that speed are accelerated once more in that division (2) and also a third time in the third division (3). The anticathode (T) protrudes outside the tube, making cooling and protection much easier than when in the vacuum as usual. X-rays emerge in an axial direction through the tungsten and copper target with almost the same intensity as at right-angles.

The tube is mounted on a small truck (Fig. 4); two columns contain oil-cooled resistances, carrying a constant current of about 1 milliampere. From this resistance used as potentiometer, the different sections of the tube are tapped off, thus receiving equal parts of the high voltage. The re-entrant parts of the sections are of great importance. They are, in fact, "double re-entrant parts," as may be seen in the drawing. Insulating rings with disks (as only shown in tube 3) are essential with them. They made it possible to reduce the length of every section, tested separately at 400 kv. to about 20 inches.

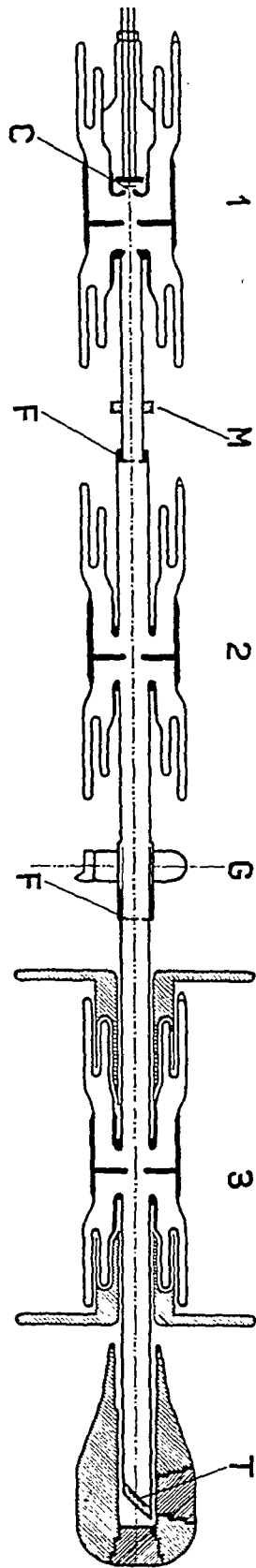


Fig. 3.

The sections are closed at the ends with thin foils and exhausted separately. The foils, F, are burned by the electron beam after the sections have been soldered together.

Another essential point is the "getter-device." Several "getters," which may be put into action by means of a filament, are built in a separate metal chamber, G, connected to the tube. One of these "getters" is sufficient to absorb the gas that is freed by the processes of soldering and burning the foils. The tube may, after exhaustion, even be opened—if it is for a short time only—soldered together and evacuated with a portable pump at the spot. The "getters" make further heating superfluous and recover and maintain a perfect vacuum afterward. A ring-shaped permanent magnet, M, is used as a focusing device to keep the beam of electrons central and within a limited cross-section.

Protection against radiation is particularly simple with the protruding anticathode. The lead round it has such a thickness that the radiation from the target has to penetrate at least 6 cm. in every direction. Several windows are provided, which can be closed or opened at will and which allow for treatment or measurement in at least four different directions. Cooling of the target is effected by the oil, that at the same time cools the potential resistances mentioned above.

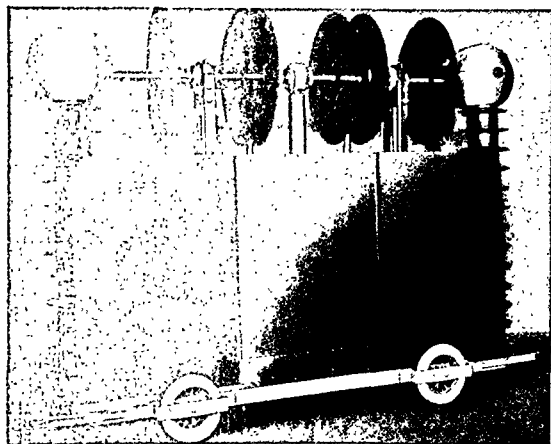


Fig. 4.

The tube is fed by a generator of the cascade type mentioned, giving symmetrical voltage: 500 kv. positive and negative (Fig. 5). The voltage is measured simply by measuring the current through the known resistance parallel to the tube. The anticathode is in this case at a potential of 500 kv. As long as treatment is carried out at a distance of 1 m. or more, patients (three or more at a time) may be placed behind a partition or a wall (serving as protection).

Another arrangement with the anode earthed and the cathode at 1 mv. is also possible with the same tube.

Some measurements have been carried out, which will be reported upon more

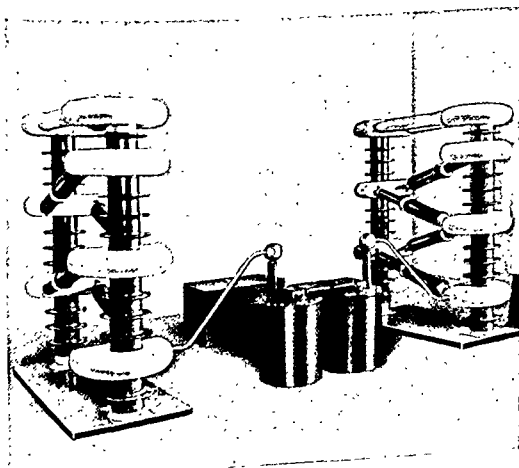


Fig. 5.

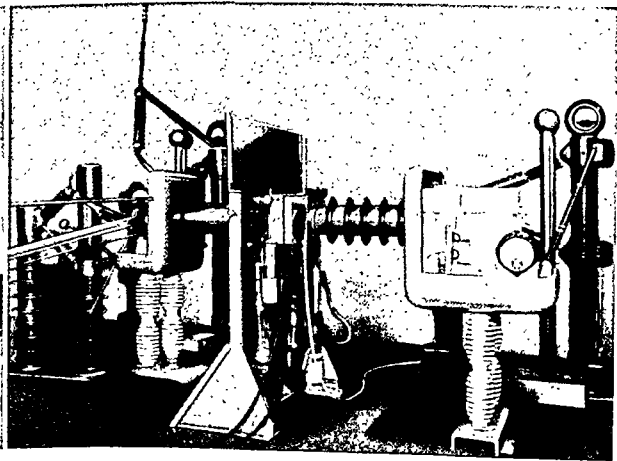



Fig. 6.

# AN EXPERIMENTAL STUDY OF THE EFFECTS OF ROENTGEN RAYS ON THE GONADS OF THE DEVELOPING CHICK

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## INTRODUCTION

 OUR knowledge concerning the effects of roentgen rays on the gonads of the developing and adult birds is very limited. Such data as are available have been obtained from studies dealing with x-ray effects on the chick embryo as a whole, and not on a specific study of the gonads. Further, a larger part of the work on birds has been done without standardized x-ray equipment and without adequate correlation of the age of the animal, dosage of x-rays, and results obtained.

We have undertaken to investigate further the problem of the effects of x-rays on the gonads of the bird under standardized conditions. The problem was divided into two parts: (1) The effects of roentgen rays on the developing chick, and (2) the effects on the adult male and female bird. The results of the first experiment are recorded in this paper.

## MATERIALS AND METHODS

The x-ray machine<sup>1</sup> used was mechanically rectified and provided with a Landauer roentgenometer. A Universal Coolidge therapy tube was used. The set-up of the machine for the entire experiment was as follows: The kilowatt meter was set at 96, which delivered 112 kv.p. as measured by the sphere gap; the milliammeter was set at 6 ma.; the focal distance was 10 inches; the filter was equivalent to 4 mm. aluminum; the roentgenometer was kept at 3.2 micro-amperes, which, by calculation, gave 0.6 r per second. The desired r, or dosage, was obtained by varying the time of exposure.

The eggs were x-rayed on a specially designed irradiation box (†), so constructed as to keep them at incubation temperature

during irradiation. It included facilities for candling and absorption of scattered rays.

Young chicks were strapped back-down, by means of their wings and legs, on a board in such a manner as to expose the gonadal region and prevent discomfort to the animal.

In all, 121 specimens were used. Of this number, 28 were controls and 93 experimental material. Of the latter, there were 18 eggs irradiated prior to incubation, 26 eggs x-rayed between 5 to 12 days' incubation, and 49 chicks were treated between the time of hatching and 21 days after hatching. Fourteen of the specimens were subjected to superimposed radiation.

All material was fixed in a solution made up of four parts of Kleinenberg's picrosulphuric acid reagent with one part of 10 per cent formaldehyde, embedded in paraffin and stained with eosin and hematoxylin.

## RESULTS: EGGS IRRADIATED PRIOR TO INCUBATION

This experiment was designed to test the effects of x-rays on the pre-stage of embryonal development. The roentgen rays may or may not affect germ cell and gonad formation. The eggs received x-ray dosages varying from 180 to 480 r. All were hatched two weeks after incubation.

The Testes. The testes proved to be normal by the x-ray. The difference appeared to be a stage of development. No tissue did not show that found in cases of x-ray injury or necrosis of the

<sup>1</sup> Type C model, made by the Standard X-ray Company.

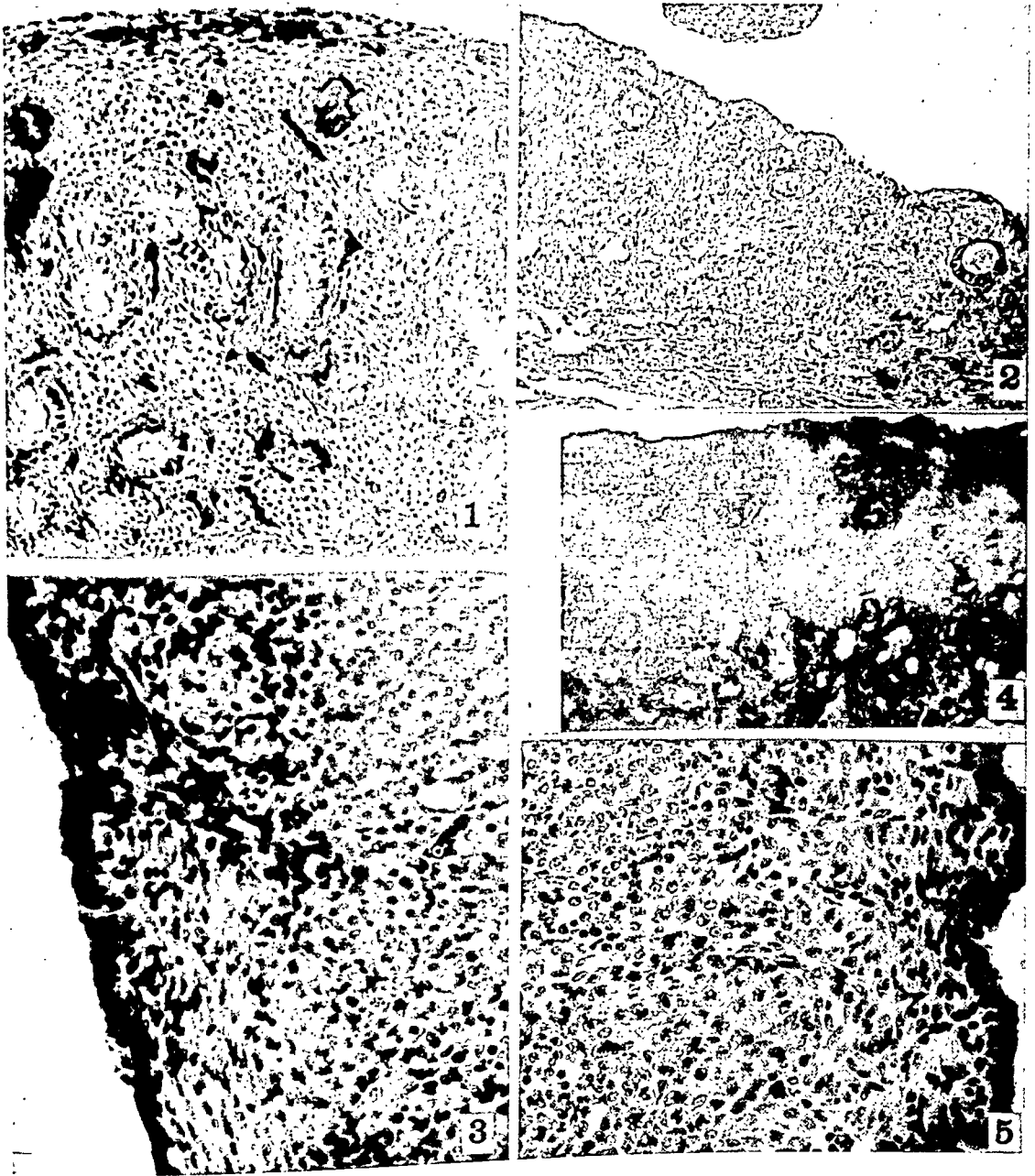


Fig. 1. Section of a testis of a 13-day-old chick showing vascular congestion. Irradiated with 100 r prior to incubation ( $\times 275$ ).

Fig. 2. Section of an ovary of a three-day-old chick x-rayed with 100 r before incubation. Note the inactive germinal epithelium, the reduction in germ cells and primary follicles, and the presence of anovular follicles ( $\times 187$ ).

Fig. 3. Section of an ovary of a two-day-old chick irradiated with 400 r prior to incubation. Note the inactive germinal epithelium, extreme reduction of germ cells, and excessive tunica albuginea ( $\times 510$ ).

Fig. 4. Section of an ovary of a three-day-old chick x-rayed with 120 r prior to incubation, showing necrotic areas in cortex and partly in medulla ( $\times 460$ ).

Fig. 5. Section of an ovary of a 18-day-old chick embryo irradiated with 400 r on the fifth day of incubation. Note the scarcity of germ cells and the excessive tunica albuginea ( $\times 488$ ).

which were rather inconspicuous in the gonads of the controls, became greatly enlarged and were gorged with blood cells in the treated material (Fig. 1). The ex-

tent of the blood congestion varied considerably, however, even in specimens treated to the same dosage of x-rays.

*The Ovaries.*—In all of these experi-

ments the ovaries have invariably shown a greater sensitivity to x-rays than the testes. Except in those treated to very low dosages, 80 r or less, varying degrees of injury could be demonstrated in practically all ovaries irradiated. The less seriously affected ovaries showed reduced mitotic index, inactive germinal epithelium, and reduced number of germ cells in the cortex. The above defects have been observed in the controls but in only a few instances. It must also be stated here that injuries of this type were commonly observed in ovaries treated to dosages in the neighborhood of 100 r; however, similar injuries were met with in ovaries that had received 300 r or more.

In the more severely affected ovaries there was found a marked reduction of primary follicles (Fig. 2). A few follicles were found that lacked the ovum, anovular, the space of which was occupied by follicular cells. In some specimens the ovaries lagged behind in development: in such, there were no follicles of any kind. The germ cells were greatly reduced in number and those that remained were segregated into definite areas or nests. In such ovaries an exaggerated development of the tunica albuginea was noted (Fig. 3).

In one specimen, necrotic areas resembling hyaline degeneration were found at different levels of the ovary (Fig. 4). In the areas so affected the germinal epithelium, the cortex, and to some extent the medulla, were involved. There was a marked reduction of germ cells and follicles in this ovary. Since only one of 18 specimens presented this anomaly, it is likely that the cause was not of x-ray origin.

#### EGGS IRRADIATED DURING THE INCUBATION PERIOD

The experiments in this group were arranged to test the effects of radiation on gonad formation. X-rays were applied to eggs between 5 and 12 days of incubation: the dosages varied from 100 to 400 r. About one-half of the specimens were killed

on the eighteenth day of incubation, the rest were sacrificed during the first week after hatching.

*The Testes.*—Contrary to expectation, the effects of the x-rays on the testes of this series were minor in nature. The gonads were comparable to those irradiated prior to incubation; the tubules seemed to be normal in size and number; the epithelium, however, lacked the normal appearance and mitosis was seldom noted. The interstitial tissue and the testicular stroma presented no perceptible departure from normalcy except for the presence of vascular congestion. The latter feature was observed more frequently and to a larger extent than in the testes of the former experiment.

*The Ovaries.*—The x-ray injuries in this experiment varied directly with the age of the embryo and the dosage, more consistently than in the ovaries of embryos irradiated prior to incubation. In the ovaries of maximum injury, dosages of 300 to 400 r, age 5 to 7 days' incubation, the oocytes which in normal ovaries of comparable age fill the entire cortex, were found to be very scarce. Instead, the peripheral part of the cortex was occupied by fibroblasts (Fig. 5). Small groups of oocytes, found in the isolated parts of the ovary, were in process of degeneration, as indicated by pyknotic nuclei and colorless cytoplasm. The germinal epithelium of such ovaries was practically one layer of cells in thickness and, of course, showed no signs of germ cell proliferation. In some parts of the cortex condensed masses of cells in the form of cords were noted, such structures always being surrounded by a connective tissue capsule and having a close resemblance to the anovular follicles (Fig. 6).

The ovaries of chick embryos irradiated with dosages ranging from 200 to 300 r, and at ages 5 to 7 days of incubation, presented less severe injuries than those of higher dosages. It was found most commonly that the middle part of the ovary was devoid of oocytes but that such were present in larger numbers at the poles, particularly

the lower pole of the ovary. Such germ cells, however, lacked the appearance of normal cells. An inactive germinal epithelium and cortical fibrosis were common features in this group.

Ovaries of embryos irradiated with dosages less than 200 r at ages more than six days presented minor injuries. At least some of them could not be distinguished from the ovaries of the controls.

#### IRRADIATION OF CHICKS AFTER HATCHING

In this experiment, it was intended to test irradiation effects on the development of the follicles, seminiferous tubules, and the interstitial cells. These chicks were x-rayed from one to 21 days after hatching, the dosages varying from 80 to 600 r. About half of the chicks were killed within five days after irradiation, the other half was sacrificed within 22 days after hatching.

*The Testes.*—In this experiment, as in the two previous ones, the testes showed a greater resistance to the effects of x-rays than the ovaries. The testes of chicks irradiated with less than 200 r were similar to the testes irradiated during incubation.

The congestion in the blood vessels of the gonad could be demonstrated in more than 60 per cent of chicks irradiated, usually occurring more abundantly in the right testicle than in the left one. There were some instances in which one of the testicles showed extensive congestion while the other appeared normal.

Other signs of destruction were noted in chicks irradiated with dosages of x-rays above 200 r. The epithelium of the developing seminiferous tubules had reached a stage of retrogression that permitted a definite interpretation. The spermatogonia were totally inactive; the cytoplasm had a pale, "washed-out" appearance, and the nuclei were pyknotic. Mitotic activity could not be demonstrated. Owing to the relatively few tubules in the gonad, one would naturally conclude that degeneration of tubules must be taking place. However, unmistakable evidence for this assumption could not be found.

It was quite apparent that the growth of the gonads was caused, not by the developing seminiferous tubules, but by the interstitial tissue. The latter was very abundant in every part of the testis (Fig. 7). The interstitial tissue was quite often seen organized into cord-like masses of cell surrounded by a definite connective capsule.

A peculiar case of melanin pigmentation in the interstitial tissue was observed in one irradiated chick. An attempt was made to repeat the anomaly, but without success: for this reason it is here described, not as a resultant of roentgen radiation but as a case of rare occurrence. Both testes appeared jet black in color when removed. Under the low power microscope it appeared as though the seminiferous tubules were roughly traced with India ink (Fig. 8). Under oil immersion the pigment was seen to consist of granules of various types, gathered into structures resembling chromatophores. There were no pigment granules in the seminiferous tubules, the structure of which appeared normal (Fig. 9).

*The Ovaries.*—A marked resistance of the ovary to x-rays was noted in chicks irradiated the first five days after hatching. The average ovary of this group may be characterized as an inactive structure in which cell division was seldom observed. Follicular degeneration was present but was limited in extent and number of specimens.

Beginning with the seventh day, the ovaries showed less resistance to x-rays of whatever dosage used: marked destruction of ovarian tissue was present in chicks that had received 400 r or more. In the more severely affected specimens, the ovary appeared to be in a hopeless stage of degeneration. The primary follicles might be entirely lacking or they might be present in small numbers: it was doubtful whether any of the latter could be called normal. They appeared pale in color as compared with adjacent connective tissue, and the cytoplasm had become vacuolated. The larger follicles persisted for a longer time but their disintegration was unmistakable.



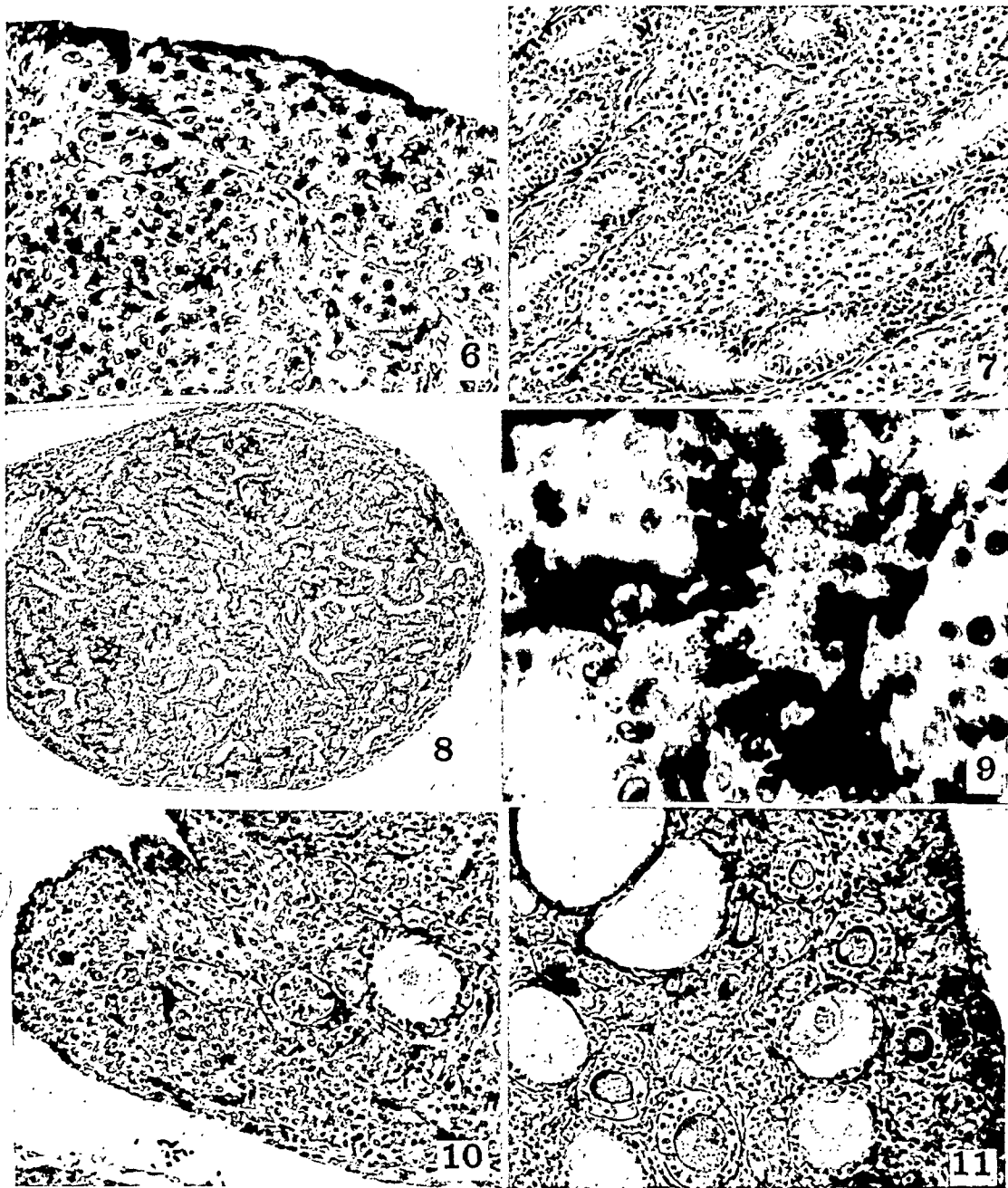


Fig. 6. Section of an ovary of a three-day-old chick x-rayed with 320 r on the sixth day of incubation. Note inactive germinal epithelium reduction of germ cells and the presence of cell-cords ( $\times 525$ ).

Fig. 7. Section of a testis of a 21-day-old chick irradiated with 600 r on the second day after hatching. Note the abundance of interstitial tissue and the relatively few seminiferous tubules ( $\times 275$ ).

Fig. 8. Section of a testis of a 14-day-old chick x-rayed on the seventh day after hatching with 480 r. Note distribution of pigment ( $\times 71$ ).

Fig. 9. The same section as in Figure 8 ( $\times 1100$ ).

Fig. 10. Section of an ovary of a 21-day-old chick irradiated on the seventh day after hatching with 400 r. Note atrophy of primary follicles and the abundance of cell-cords ( $\times 275$ ).

Fig. 11. Section of an ovary of a 22-day-old chick irradiated on the twentieth day after hatching with 600 r. Note anovular and hemorrhagic follicles ( $\times 300$ ).

The first step in the atrophying follicle was the loss of staining affinity; then the cytoplasm shrank and became vacuolated.

While the ovum atrophied, the granulosa proliferated cells that occupied the vacant space left by the degenerating ovum. In

the next stage the anovular follicle had the appearance of a solid, spherical mass of cells. However, this spherical body soon became an elongated, cord-like structure (Fig. 10).

If the chicks were killed and the ovaries fixed within 48 hours after irradiation, anovular follicles were common but the spaces of the destroyed ova were more often filled with blood than granulosa cells (Fig. 11). Initial stages of vacuolization of the cytoplasm of larger follicles were noticeable in these specimens.

Ovaries that have suffered extensive oocyte and follicle destruction invariably show large increase in interstitial cell content. Fibrosis of the cortex, particularly beneath the germinal epithelium, and vascular congestion were additional features commonly observed in these ovaries.

The ovaries irradiated with lower dosages (200 r or less) did not differ materially from those x-rayed during the first six days after hatching. At least some were found that were normal as far as could be diagnosed under the microscope.

#### SUPERIMPOSED IRRADIATION

An attempt was made to ascertain the effects of double irradiation of the same specimen. The first application of x-rays was given during the incubation period and the second after hatching: altogether, 14 specimens were used for this purpose.

*The Testes.*—The superimposed dosages have added no new features to the picture of the testes, but the effects have been accentuated to such an extent that they could be recognized readily. Blood congestion was prevalent in this material. Totally sterile testes were found in specimens in which each of the two dosages were 200 r or more. The seminiferous tubules were abnormal in size, shape, and number. One and the same tubule may extend from one pole of the testis to the other pole. Abnormal enlargements and constrictions in the tubules were noted. Their number was found to be reduced to about one-half the normal in the right testis and approximately one-third in the left testis (Fig. 12).

The reductions seemed to be brought about by the degeneration of the partly differentiated seminiferous tubules. The cell masses, having great similarity to interstitial cells, were common in such testes, and at least some of them were enclosed in distinct connective tissue sheaths. However, a continuation between interstitial cell masses and degenerating seminiferous tubules was not established.

*The Ovaries.*—The findings for the ovaries were similar to those for the testes of this group. The observable anomalies were not new but represented summations of x-ray injuries that were noted, to a lesser extent, of course, in all the material studied.

In the ovaries with maximum injury in which the sum of the dosages was above 350 r, there were no normal follicles of any description. Anovular follicles and cell cords were the most outstanding features. Growing follicles, few in number and widely scattered, were found in some ovaries but they showed unmistakable signs of degeneration. The germinal epithelium was reduced to practically one layer of cells in thickness (Figs. 13 and 14).

The cell cords were, to all appearances, derived from the anovular follicles. The cell types of both structures were identical as far as could be discerned under the microscope. Anovular follicles developed into cell cords by elongation: they were always found in the ovarian cortex and usually close to the surface. These cords appeared to have grown rapidly, the larger ones always curved. In some parts of the ovary, the cortex was occupied mainly by cell cords and interstitial tissue (Fig. 15). After having gone through a certain amount of growth the constituent cell of the cords took a peripheral position and a lumen developed centrally. Such newly formed tubes have a marked resemblance to the seminiferous tubules of chicks at about the time of hatching. The developmental processes of the two structures were similar (Fig. 16).

Another male structure observed in the x-ray damaged ovary was the tunica

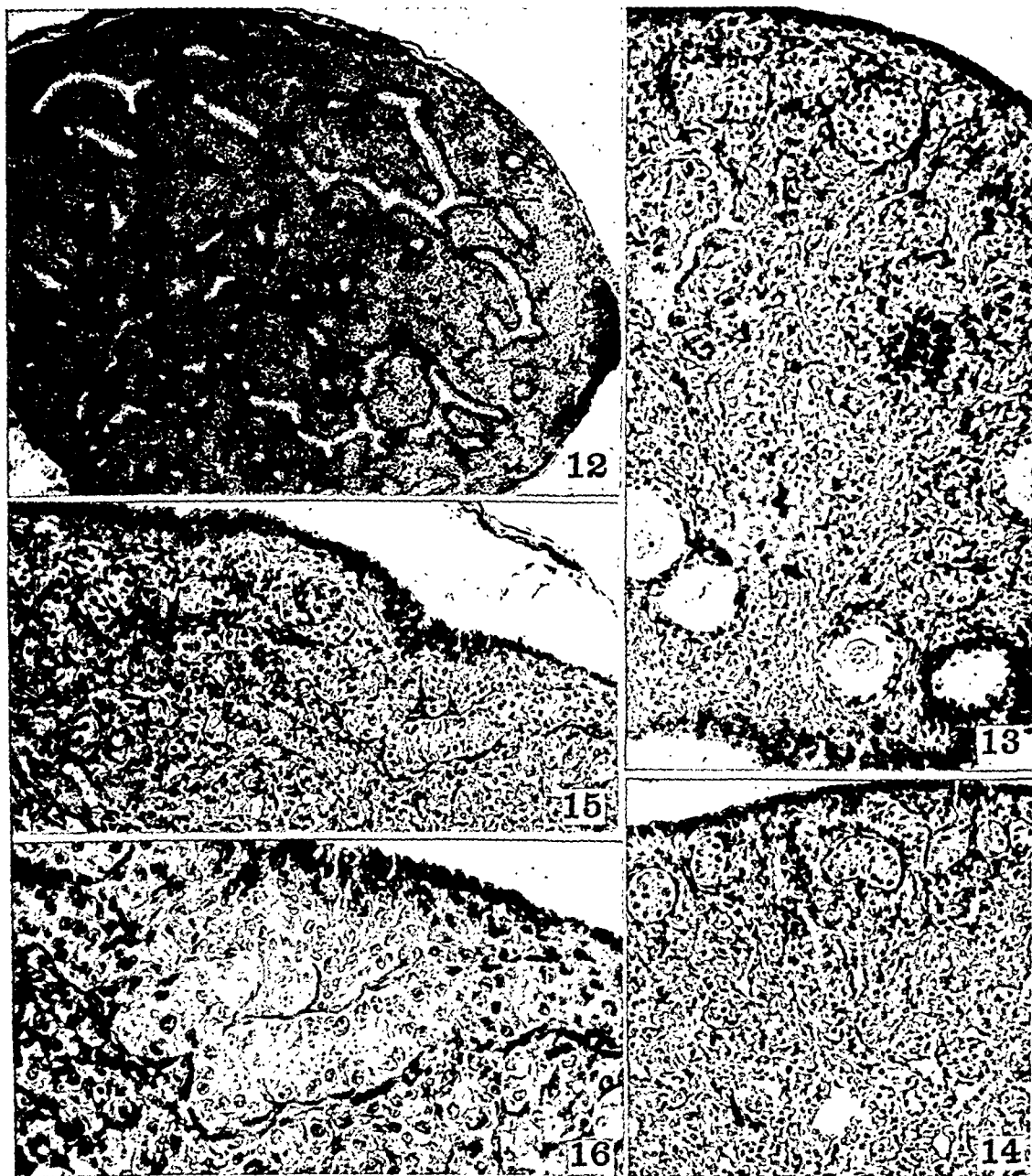


Fig. 12. Section of a testis of 25-day-old chick irradiated with 240 r at 70 hours' incubation and again on the seventh day after hatching with 240 r. Note the abundance of interstitial tissue and the reduction of seminiferous tubules ( $\times 89$ ).

Fig. 13. Section through the upper pole of an ovary of a 25-day-old chick x-rayed with 240 r at 70 hours' incubation and again on the seventh day after hatching with 120 r. Note cell masses and cell-cords and degenerating follicles ( $\times 285$ ).

Fig. 14. Section of the middle of the same ovary as in Figure 13. Note cell masses and cords ( $\times 275$ ).

Fig. 15. Section through the lower pole of the same ovary as in Figure 13. Note cell masses, cords, tubules, and an exaggerated tunica albuginea ( $\times 275$ ).

Fig. 16. Same section as in Figure 15 ( $\times 540$ ).

albuginea (Figs. 3, 5, 13, and 15). In the normal ovary the tunica albuginea is very inconspicuous at any time of development or adult life: in the irradiated ovaries it

was perhaps thicker than in the growing testes.

Well developed lymph nodes have been found in irradiated gonads, occurring most

commonly in ovaries of superimposed radiation. However, their occurrence was not directly related to age of the irradiated specimen nor to the dosage used.

X-ray effects on organs of the incubating chick other than the gonads have been noted in these experiments. The results were studied and described by the senior author (3).

#### DISCUSSION

The effects of x-rays on mitotic activity have been noted in all of our experimental material. With small doses, 80 r or less, and with the present set-up of the x-ray machine, recovery takes place in a few hours. In dosages between 100 and 550 r, recovery is retarded, and with 600 r recovery seldom occurs. The latter is due to the fact that 600 r approximates very closely the lethal x-ray dose in the chick embryo. After the recovery from the initial effect, the mitotic activity shows retardation in dosages above 80 r and acceleration with dosages less than 80 r. Acceleration in the development of the chick has been reported by Gilman and Baetjer (6) and by Essenberg (2).

Marked resistance to the influence of x-rays was noticed in embryos irradiated before incubation and in chicks treated the first six days after hatching. In the first instance, the embryo was in an arrested stage of development; the metabolic and growth rates were low; thus, as would be expected, the injuries caused by x-rays were minor in character. We are inclined to assume that the same condition prevails in the second case. In chicks as in mammals, there is a drop in weight the first few days after birth, indicating a reduced growth rate.

It is now a well established fact that x-ray injuries vary directly with the dosage and with the age of the specimen. We have found it a guiding principle in all of the phases of our work. However, as was indicated above, exceptions to this rule have been noted. The more careful study of this problem was done by the senior author (3 and 5). It was found that the

absorption of x-rays by the shell was a negligibly small factor, amounting to from 3.33 r to 6.66 r per 600 roentgen units. It was concluded that the "hereditary and environmental factors prior to laying play the major rôle."

With the present set-up of the machine and with the dosages varying from 40 to 600 r, the testes proved to be more resistant to the injuries of x-rays than the ovaries in every phase of the experiment. For an initial injury, involving an inhibition of mitosis, retrogressive changes in nucleus and cytoplasm of the spermatogonia, 200 r was required. For major injuries, involving the degeneration of the seminiferous tubules, from 300 to 600 r was required. In the ovaries, on the contrary, initial injuries were obtained with from 80 to 100 roentgen units. Injuries to the germinal epithelium, the primary follicles, and the formation of cell-cords resulted from dosages of 200 r. Major injuries, consisting of the destruction of primary and growing follicles and the formation of cell-cord tubules, appeared in dosages of 300 roentgen units.

The differential susceptibility to the effects of x-rays of the gonads of the two sexes is very likely due to more than one cause. We assume that the major cause is to be sought in the fact that the germ cells of the two sexes are at different levels of germ cell differentiation during the time of irradiation. In the ovary the germ cells go through developmental stages from oogonia to oocytes, primary follicles and growing follicles, whereas in the testes they seldom go beyond the spermatocyte stage.

The growth in size of the x-ray injured testes is not caused by the differentiation of the seminiferous tubules but by the increase of interstitial cells. The latter differ from interstitial cells of the controls by being segregated from the tubules and the testicular stroma by a rather definite connective tissue membrane. The cell structure of interstitial cells of the normal and the treated testes are identical as far as can be judged by inspection. It is possible that the ensheathed interstitial cell masses of the

x-ray injured testes originate from broken-down seminiferous tubules. It is also of interest to note that the right testis is invariably more susceptible to x-rays than the left one.

Probably the most peculiar findings of the entire experiment are the cell-cords of the ovaries injured by x-rays. They were noted in every phase of the experiment; the formation of the tubules was not, however, identified before the stage of superimposed irradiation. Most of the cell-cords seem to take origin from young follicles. They may, however, originate from germ cells that are in the process of follicle-formation, as indicated by the presence of cell-cords in ovaries in which primary follicles have not yet formed. At first they are spherical masses of cells ensheathed by a connective tissue membrane. Such structures were found most abundantly in ovaries that were irradiated during the time when primary follicles were in formation, *i.e.*, beginning from the sixth or seventh day after hatching. The cell-cords are produced by elongation of the spherical bodies. By rearrangement of the cells a lumen appears in the center. As stated before, the tubules resemble closely the developing seminiferous tubules of the normal male chick at the time of hatching. The developmental processes of the seminiferous and the cell-cord tubules are similar. The third male sign is the formation of an extensive tunica albuginea in the x-ray injured ovaries. It is possible that sex-inversion from the female to the male sex has taken place. However, further experimentation is needed before a definite statement can be made.

In comparing our results with those obtained by others (Hooker, 8; Snyder, 11; Murray, 10; Bagg and Little, 1), it would appear that the gonads of birds are more resistant to x-rays than those of mammals. Although these investigators have obtained injuries to testes and ovaries with much lower dosages, it is difficult, if not impossible, to correlate the erythema dose with that of the roentgen unit and the

set-up of one machine with that of another. Allowing for individual variation, which is rather extensive, strict comparisons can be made only with the same set-up of the machine and with similar effects. One such comparison which has come out of this laboratory is available at the present time. Job, Leibold, and Fitzmaurice (9) showed that hydrocephalus can be induced in embryo rats at the ninth to eleventh day of pregnancy with a dosage averaging 52.5 r. The same effect was obtained in the chick embryo (3), at the average age of five and one-third days of incubation and an average dosage of 217 r.

#### SUMMARY

In these experiments 121 specimens were used. Of these, 28 were controls, 18 eggs were radiated prior to incubation, 26 embryos were x-rayed at ages 5 to 12 days' incubation, and 49 chicks were treated to roentgen rays at ages 1 to 21 days post-hatching. Of those irradiated during incubation, 14 received a superimposed dosage after hatching. The dosage of x-rays varied from 40 to 600 r. The results are as follows:

(1) X-rays of any dosage effect the mitotic activity. Recovery is rapid with dosages 80 r or less; slow in dosages above 80 r; rare with a dosage of 600 r.

(2) Marked x-ray resistance was found to occur in embryos prior to incubation and in chicks during the first six days after hatching.

(3) Interference with mitotic activity and arrest of development of the ovary was caused by dosages above 80 r. Injuries to the germinal epithelium, the primary follicles, and the formation of cell-cords resulted from dosages 200 r and above. The destruction of follicles and the formation of tubules occurred in ovaries treated to 300 r or more.

(4) The testes showed a greater x-ray resistance than the ovaries. Initial injuries occurred in testes treated to 200 r. Major damages consisting of the degeneration of seminiferous tubules followed by increase of interstitial cells required above

300 r. The left testis proved to be more x-ray resistant than the right.

(5) In ovaries of major injury three apparently male characteristics were noted: The tubules resemble closely the seminiferous tubules of a young male chick; the process of formation of the seminiferous tubules and the tubules resulting from cell-cord are similar; a male tunica albuginea was formed in such ovaries. It is possible that sex reversal from female to male can be induced by x-rays.

(6) The gonads and the tissues of birds in general appear to be more x-ray resistant than those of mammals.

(7) Individual variation is much in evidence.

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# HOW X-RAYS MAY KILL CELLS<sup>1</sup>

By HILLYER RUDISILL, JR., M.D., Professor of Radiology and Electrology, Medical College of the State of South Carolina, and J. HAMPTON HOCH, D.Sc., Professor of Botany and Pharmacognosy, Medical College of the State of South Carolina, Charleston, S. C.

THE experimental work for this presentation was begun with the intention of studying a specific action of x-rays on cells that might account for their destruction by irradiation. While there have been many theories propounded to account for the lethal action of x-rays on cells, most of them are so generalized (e.g., destruction of protoplasmic organization, injury to the nucleus or cytoplasm, increased permeability of plasma membrane, enzyme inactivation, protein precipitation, etc.) that they do not really explain why cells die when exposed to sufficient x-rays.

Before beginning our experiments we made a careful survey of the work done on the effects of radiation on cellular physiology. Most experiments with x-rays were directed toward a measurement of growth inhibition or cell death and comparatively few were aimed at determining radiation effects on specific metabolic processes of the cell. It seemed that respiration,<sup>2</sup> as a fundamental function of the cell, was capable of radiation injury; and that when the respiratory mechanism is interfered with serious derangement of other functions or death ensues (1).

Since a spectroscopic method of study of certain components of the cellular respiratory chain is convenient and sufficiently accurate, we elected to do our experimentation along this line. Yeast cells were chosen for the study for the following reasons:

1. With unicellular organisms the relative simplicity of cell mechanisms makes recovery from injury more difficult since there are no other cells to take over im-

paired functions. Recovery means the reconstruction of a lost function.

2. Small organisms are obviously necessary so that the energy received is essentially equal for all test objects.

3. The size of a sensitive zone, according to Holweck's (2) calculations based on the quantum hit-to-kill theory, approximates that of the yeast nucleus. Mayneord (3) has calculated a curve of probability of a cell five microns in diameter being traversed by an electron per unit of absorbed energy at various wave lengths (considering both photoelectrons and recoil electrons).

4. Yeast has a comparatively high rate of glycolysis; thus, it simulates a character of cancerous tissue.

5. The rapid multiplication and ease of culture enables one to deal with large numbers of individuals.

6. Its tested adequacy for cytochrome studies and its resistance to  $pH$  values so low as to be toxic to most cells, as well as the fact that extensive data relative to its metabolism have been accumulated which justify yeast's designation as the "Guinea pig of the biochemist."

Cellular respiration is carried on through reduction-oxidation reactions, the so-called "redox" systems. These reduction-oxidation reactions involve the virtual transfer of electrons. Water comprises the great bulk of protoplasm and a study of the action of x-rays on water is very illuminating. Risse (4) and Nurnberger (5) have shown that water becomes more acid and electrically is more conductive when irradiated; and Fricke (6) and others have shown that hydrogen and hydrogen peroxide are formed. Since redox systems are profoundly influenced by changes like these, it would be strange if the reduction-oxidation of the cells remained unaffected

<sup>1</sup> Presented before the Fifth International Congress of Radiology in Chicago, Sept. 16, 1937.

<sup>2</sup> The term "respiration" as used herein signifies all the energy-yielding reactions of the cell.

by irradiation. Further, as cellular damage resulting from x-rays shows a latent period and autocatalytic reactions likewise exhibit a preliminary lag phase, and since the so-called after-effect found in irradiated cells may also be exhibited by photochemical reactions, it seems logical to assume that the autocatalytic mechanisms governing the redox equilibria are affected by x-rays.

These catalysts function in maintaining a definite rate of cell metabolism and attempt to restore normal function when anything interferes with the cellular physiology. Since sudden changes in the respiratory needs of the cells cannot be met by sudden increase in those catalysts which are heavy metal complexes (e.g., iron in cytochrome), secondary systems of catalysts are necessary to maintain activity of the primary ones. Co-catalysts are required for many reactions (e.g., most glycolyses).

The primary catalysts of the cell's respiratory mechanism are the dehydrogenases, which activate hydrogen, and the oxidases, which activate oxygen. The bulk of cellular respiration is accomplished through the dehydrogenases and their co-catalysts. These complexes do not react directly with molecular oxygen but they do function with the intracellular hemes such as cytochrome through the flavoproteins. The co-catalyst portion of such a complex<sup>3</sup> transports hydrogen by the transformation of its pyridine nucleus to dihydropyridine. Such reduced co-catalysts are not autoxidizable but flavoprotein dehydrogenates them by itself becoming reduced to its leuco-form. The leuco-flavoproteins are oxidized through the cytochrome pigments. Nascent hydrogen by over-reduction of the co-catalyst causes irreversible inactivation, transforming the pyridine nucleus into a piperidine nucleus. Hydrogen peroxide also destroys or inactivates the co-catalyst which has been reduced physiologically.

The effect of x-irradiation on the redox system was studied by determining the time necessary for the reappearance of the cytochrome C absorption band in the visible spectrum following oxygenation. In brief, the following experiments were carried out (technical details of which will be reported elsewhere). A 7.5 per cent suspension of yeast, in phosphate buffer, was studied spectroscopically by trans-illuminating the yeast suspension with the light from a carbon arc. The cytochrome C line at 550  $m\mu$  was identified, verifying previously reported studies of others. The yeast suspension was then irradiated in a small flat-bottom dish and the cytochrome C absorption band was obliterated by bubbling oxygen through the yeast suspension. The disappearance of this cytochrome C band is the result of a temporary oxidation which changes the ferrous compound to ferric compound, the latter failing to show an absorption band at 550  $m\mu$ . Functioning normally the dehydrogenases reduce the ferric to the ferrous form and the absorption band reappears within a comparatively short period of time. (Under our experimental conditions this time varied roughly from one to two and one-half minutes.) Thus the dehydrogenases re-established the normal redox equilibrium of the cell.

With x-ray dosages of from 3,000 to 6,000  $r^4$  (150  $r/min.$  at 115 kv.p., 15 ma., 25 cm. distance and inherent tube filtration of from 3 to 4 mm. Al) the cytochrome C band did not reappear after oxygenation until from three and three-fourths to five and one-half minutes had elapsed, an average initial increase of 225 per cent. This we interpret as signifying definite although not irreparable damage to the dehydrogenase complex. The transitory nature of this effect indicates the ability of the injured cells to recover and but serves to emphasize the fundamental protoplasmic property of repair in the living organism. Since we used intact, living cells and util-

<sup>3</sup> The cozymase of yeast and Warburg's coenzyme are, respectively, di- and tri-phosphopyridine nucleotides; these function as co-catalysts.

<sup>4</sup> These are comparatively small dosages for yeast as the half lethal dose has been established as 42,000  $r$  (7).



ized one component of the cellular redox chain as an indicator of the x-ray effect, this method permits direct, *in vivo* observation and measurement of the action of x-rays on intracellular metabolic processes. The method, without refinement, is not ideal as a quantitative procedure but it does adequately serve the purposes of this investigation; although the values obtained are not absolute values, the use of a control for each measurement and the duplication of individual peculiarities from experiment to experiment gave consistent results and comparable findings.

Correlating these facts with the proven ability of roentgen rays to produce both nascent hydrogen and hydrogen peroxide, we believe that the biological effects of x-rays on cells may result from inactivation or destruction of cell respiratory mechanisms through the effects of these substances on the co-catalysts of the dehydrogenases. Further, we believe that the cytochrome spectrum is an accurate indicator of this effect.

The wide distribution in nature (from yeast to man) of catalytic complexes containing pyridine nuclei as active components points to the fundamental rôle of such compounds in life processes. The formation by x-irradiation of the aqueous protoplasm, of hydrogen and hydrogen peroxide furnishes the means of inactivation or destruction of this active group so essential to the functioning of the fundamentally important systems of which they are a part. Among the well-authenticated and established effects of x-ray action on living cells the following are, we believe, adequately explained by the above reactions. Likewise they furnish criteria upon which the usefulness of any hypothesis of x-ray action on cells may be judged.

1. The differential susceptibility of different kinds of cells and tissues to x-rays and the increased susceptibility of young or rapidly growing cells seems very definitely connected with their higher metabolic rate and increased water content. The higher the metabolic rate, the greater the sensitivity. The more active respiratory mechanism required by such cells renders them especially sensitive to damage such as we have described.

2. The ability of an irradiated cell to recover from sub-lethal exposure to x-rays is to be found in its ability to elaborate more catalyst to replace that which was inactivated, and to do it rapidly enough to meet its own particular respiratory requirements.

3. The cumulative effect of divided small doses depends upon a time spacing less than that required by the cell to elaborate enough catalyst to completely replace the inactivated catalyst.

4. The delayed lethal action of x-rays on cells (latent period) finds explanation in the fact that the reaction chain involved contains auto-catalysts.

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## CASE REPORTS AND NEW DEVICES

### THE USE OF AQUAPHOR IN IRRADIATION EPIDERMITIS

By IRA I. KAPLAN, B.S., M.D., and SIDNEY RUBENFELD, B.S., M.D., Bellevue Hospital, New York City

From the Radiation Therapy Service of Bellevue Hospital, Ira I. Kaplan, M.D., Director

When Coutard, in 1932, introduced his method of protracted fractional irradiation he advocated doses which by reason of their intensity, produced severe reactions on the skin. These were manifested successively by erythema, increased pigmentation and blistering, but as the quantity of x-rays was administered in fractions, complete healing of the skin followed. In the technic as advocated by Coutard the skin reaction appears about the sixteenth to the twenty-first day, progresses to blistering and persists for about 14 to 21 days.

This therapeutic procedure is at the present time quite generally employed but many therapists utilize modifications of Coutard's original technic, with treatments administered to the stage of skin denudation. Subsequent reaction is of considerable discomfort to the patient because of the burning, weeping, angry red effect. Moreover, this does not permit the concurrent use of interstitial radium therapy for residual metastatic glands, should the plan of treatment call for this.

In the Radiation Therapy Service at Bellevue Hospital we employ both the regular Coutard technic, and also the modifications thereof, in which doses are given to the stage of skin destruction. For the past several years, we have used innumerable types of ointments and solutions, the formulas for which either originated with us or were suggested in the literature. Among these were solutions of boric acid, azochloramid, caroid, sea water, bland ointments such as zinc oxide, boric acid, yellow oxide of mercury, radolatum, joncolia, borofax, vaseline, nupercaine, and alvangel (made from aloes vera leaf), etc. None of these substances, however, gave any noteworthy relief from the burning pain or lessened the time required for healing the radiation skin reaction.

Having long noticed that excessive weeping in a radiation epidermitis was a constant finding, we engaged in an intensive search for a bland ointment capable of combating this serious oozing, and thus chanced upon Aquaphor.<sup>1</sup>

Aquaphor is cholesterolized petrolatum. It has an absorption base containing as the active

hydrophylic ingredient, 6 per cent of a group of esters of cholesterol in an aliphatic hydrocarbon base. It appears as a pale yellow, semisolid, odorless unguent that is neutral in reaction and has the property of absorbing at least 200 per cent water by weight. Aquaphor mixes well with fatty and aqueous excretions of the skin; it spreads easily and melts at body skin temperature.

In using, the ointment is applied in a thin film directly over the reactive area, preferably without any gauze bandage. To the patient the relief from burning is immediate and lasting; objectively, healing is hastened by days. The most convincing proof of the superior efficacy of this ointment appeared when Aquaphor was used as a regular routine in the care of patients treated with protracted irradiation. These patients volunteered the opinion that they had obtained greater relief from the new ointment than from any other theretofore used.

After an observation of a very large number of cases treated with Aquaphor, we have noted that this ointment is somewhat caustic to the normal skin because of its hygroscopic property. Therefore, we recommend that caution be employed and that the ointment be applied as closely as possible within the confines of the treated area.

To date, Aquaphor has, in our opinion, proven the most efficient remedy in combating the burning pain of radiation effects on the skin.

### ONE AND ONE-HALF YEARS' EXPERIENCE IN THE EMPLOYMENT OF 220 KILOVOLTS X-RAY THERAPY WITH HEAVY FILTER

REPORT ON SEVEN CASES OF CARCINOMA OF THE BLADDER

By ROBERT H. LAFFERTY, M.D., and C. C. PHILLIPS, M.D., Charlotte, N. C.

For thirteen years prior to April, 1936, we had employed 200 kv. x-ray therapy with 0.5 mm. Cu filter in the treatment of cancer. At that time we began using a Westinghouse Pulsating X-ray Therapy Machine, 220 kv., 20 ma., 50 cm. T.S.D., with filter consisting of 0.77 mm. Sn plus 0.25 mm. Cu plus 1 mm. Al, H.V.L. 2.55 mm. Cu, equivalent on a quality basis to 3.75 mm. Cu.

We have been very much gratified with the improvement in results obtained by this method, in all types of cancer located deep within the body, as compared with our former method of treatment.

<sup>1</sup> Aquaphor was supplied for these clinical tests through the courtesy of the manufacturers, the Duke Laboratories, Long Island City, New York.

From July, 1936, to March, 1937, we treated seven cases of carcinoma of the bladder, in all of which we had histologic diagnosis.

#### CASE REPORTS

Case 1. J. B. J., white male, aged 56 years; referred by the Crowell Clinic. He gave a history of hematuria for two months. A papillary tumor was found in the bladder and as much of it as possible was removed by the resectoscope.

The pathologist's report was papillary epithelial neoplasm showing solid medullary extensions at base. Treating the papillary carcinoma, the patient was given a total of 9,000 r to the pelvis through five  $15 \times 15$  cm. skin portals, in doses of from 225 to 300 r over a period of 57 days. On the twenty-eighth day there was extensive hemorrhage from the bladder and it was necessary to suspend treatment for two weeks. The patient is clinically and cystoscopically well 16 months after treatment.

Case 2. S. J. L., white male, aged 65 years; referred by the Crowell Clinic. History of hematuria for three weeks. The cystoscopist found an infiltrating tumor in the bladder and removed a part of it by the resectoscope. The tissue showed epidermoid carcinoma. A total dose of 9,000 r was given to the pelvis through five skin portals  $15 \times 15$  cm. in size. The treatment was given over a period of 51 days, 225 r being given at each treatment. The patient is carrying on his work as a farmer but will not report for observation. It has been 16 months since he was treated.

Case 3. J. R. W., white male, aged 65, referred by Dr. McKay and associate. He gave a history of two hemorrhages from the bladder within a month. On cystoscopy by Dr. H. W. McKay, a small papillary tumor was found in the bladder and removed by the resectoscope, after which the base was fulgurated. The tissue showed malignant papilloma. A total of 9,000 r was given to the pelvis through four  $15 \times 15$  cm. skin portals over a period of 46 days. One area was treated each day with 225 r. Fourteen months after treatment cystoscopy reveals no newgrowth in the bladder and there is no evidence of metastasis.

Case 4. B. H. G., white male, aged 65 years, referred by the Crowell Clinic. There was a history of resection of a benign hypertrophied prostate three years before, frequent hematuria during the intervening years. Five weeks before reporting to the Crowell Clinic he had complete obstruction. There was great enlargement of the prostate, with some nodules projecting into the bladder. Perineal prostatectomy was done and the tissue was studied by Dr. L. C. Todd, with the following

findings: "Benign adenomatous hypertrophy of the prostate. There is an infiltrating epithelial neoplasm derived from the bladder mucosa which has extended into the base and up into the matrix of one of the intravesical nodes, producing necrosis with secondary softening and hemorrhage. Carcinoma of the bladder wall infiltrating the prostate. High degree of malignancy." The patient was given 10,000 r to the pelvis in doses of 225 r each, through six  $15 \times 15$  cm. portals. The total dose was given in a period of 51 days. The patient is clinically and cystoscopically well eleven months after treatment.

Case 5. Mrs. H. A. G., white female, aged fifty years, referred by the Crowell Clinic. For five months she had hematuria at frequent intervals. There were three small tumors in the bladder; of these, one was 1 cm. in diameter and two about 3 mm. in diameter each. Biopsy was done and the tumors fulgurated. The material was found to be papillary carcinoma of a high degree of malignancy. A total of 11,000 r was given to the pelvis through five  $15 \times 15$  cm. skin portals in doses of 225 r. In nine months she had recurrence of the cancer in the bladder. She is being treated with x-rays (220 kv., 15 ma., 100 cm. distance, Thoraeus filter, 0.462 Sn) twice daily, 150 r at each treatment.

Case 6. F. R. U., white male, aged 57 years, referred by the Crowell Clinic. He gave a history of hematuria of four months' duration: no pain and no obstruction: there was a large tumor in the right side of the bladder and the prostate was enlarged. A part of the tumor and of the prostate were removed by the resectoscope; in all, three grams of tissue were removed. The pathologist's report was as follows: "The specimen consists largely of muscular elements and in one area near the bladder mucosa shows a deep infiltration of transitional carcinoma presenting in its deeper portions a high degree of malignancy. Carcinoma of the bladder (malignancy Grade 4)." Over a period of 57 days a total of 11,250 r was given to the pelvis through five portals,  $15 \times 15$  cm. each. The daily dose was 225 r to one area. Four months later the patient had hematuria. He was cystoscoped and the bleeding point was fulgurated. Biopsy was done at this time and the material showed carcinoma (Grade 4). The patient is living eight months after treatment, but has residual cancer in the bladder.

Case 7. F. S. W., white male, aged 41 years, referred by the Crowell Clinic. He had hematuria for nine months and there was severe pain in the bladder region. There was a tumor  $2.5 \times 2.5 \times 2.5$  cm. in the right anterior part of the bladder. Biopsy material showed squamous-cell carcinoma (Grade 3).

There was infiltration of the muscle. Treatment was begun and 6,345 r was given to the pelvis in 32 days. At that time the pain in the bladder region was so severe that it was necessary to suspend treatment. Cystoscopy revealed that the tumor had grown rapidly while receiving x-ray treatment. The patient died four months after treatment was begun. At autopsy it was found that the tumor had invaded about half of the bladder wall and it almost filled the bladder cavity.

The doses reported in all the cases are of r measured in air.

Three of these patients had papillary carcinoma, while four had the infiltrating type. Two of the three papillary tumors showed good response to the treatment, while one of them recurred in nine months. Two of the infiltrating tumors have shown good response to the treatment, while two did not show satisfactory response.

Of the seven patients, six are living from eight to sixteen months. Two have residual malignant disease in the bladder, and one of these (Case 5, a papillary tumor) is now having x-ray treatment for the second time. One, a farmer, is carrying on his work but refuses to come in for cystoscopic observation, though, so far as we can determine, a good result was obtained. In three of the cases we have cystoscopic evidence that the tumor was completely destroyed and that there has, as yet, been no recurrence.

On account of improvement in results with this method of treatment, we are now employing 220 kv. constant potential and using 6 mm. Cu filter (equivalent) in the treatment of

tumors in the deeper structures. With the greater filtration we believe that the results will be proportionately improved.

We are fully cognizant of the fact that this small series of cases, the results obtained in them, and the short time since they were treated do not constitute sufficient evidence from which to draw any positive conclusion. However, the improvement in immediate results from methods employed in these cases encourages us to believe that there will be improvement in final results as compared with those obtained by former methods of treatment.

#### ADDENDUM

Six months have elapsed between the time this paper was written and its publication.

Case 1. This individual is still living and well 22 months after treatment; Case 2, 22 months; Case 3, 20 months; Case 4, 17 months.

Case 5. Mrs. H. A. G. had recurrence nine months after treatment. This tumor was fulgurated and she was given a second series of treatments with the following factors: 100 cm. distance, 220 kv., 15 ma., Thoraeus filter equivalent to 2 mm. copper. A total of 5,230 r was given to each of four areas—one anterior, one posterior, and one to each side of the pelvis. The patient is now, 17 months after beginning treatment the first time, clinically well and cystoscopically free from tumor.

Case 6 had a recurrence four months after treatment and lived a total of twelve months.

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# RADIOLOGICAL SOCIETIES IN THE UNITED STATES

*Editor's Note.*—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section. Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—*Chairman*, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary*, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

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*Los Angeles County Medical Association, Radiological Section.*—*President*, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president*, E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary*, Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer*, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

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*Pacific Roentgen Club.*—*Chairman*, Raymond G. Taylor, M.D., 1212 Shatto St., Los Angeles; *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco.

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*San Francisco Radiological Society.*—*Secretary*, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

## COLORADO

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## MAINE

See New England Roentgen Ray Society.

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*The St. Louis Society of Radiologists.*—*President*, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

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## PENNSYLVANIA

*Pennsylvania Radiological Society.*—*President*, Charles S. Caldwell, M.D., 520 S. Aiken, Ave., Pittsburgh; *First Vice-president*, Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president*, Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer*, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor*, William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

*Philadelphia Roentgen Ray Society.*—*President*, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president*, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary*, Barton H. Young, M.D., Temple University Hospital; *Treasurer*, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 p.m.

*The Pittsburgh Roentgen Society.*—*President*, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary*, Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 p.m., from October to June at various hospitals designated by program committee.

## RHODE ISLAND

See New England Roentgen Ray Society.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—*President*, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer*, Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## SOUTH DAKOTA

Meets with Minnesota Radiological Society.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee State Radiological Society.*—*President*, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president*, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—*President*, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect*, Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president*, C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president*, M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer*, G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

## VERMONT

See New England Roentgen Ray Society.

## VIRGINIA

*Radiological Society of Virginia.*—*President*, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

## WASHINGTON

*Washington State Radiological Society.*—*President*, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—*Secretary*, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

*Radiological Section of the Wisconsin State Medical Society.*—*Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 p.m., Room 301, Service Memorial Institute.

# EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

## IS A ROENTGENOLOGIST A DOCTOR?

The radiologist has his own peculiar trials and tribulations and occasionally he boils over and writes about them to the editor. The following letter will strike a sympathetic chord in the breast of many a radiologist.

During the past ten years I have listened to considerable discussion regarding the forces which menace the existence of roentgenologists. There is the hospital with its capitalistic yen for group insurance. There is the competition of the lay "x-ray specialist" which, I understand, has been legitimated in some States. A condition, however, which impresses me as being a still greater menace hereabouts has received comparatively little attention. I refer to the attitude of the practising physician himself on whom the roentgenologist must depend for referred work.

I have practised roentgenology for ten years in a Western city of 140,000 population, the medical personnel of which is somewhat mixed as to standards. We have a part-time medical school which necessitates the completing of a medical course elsewhere and this situation tends to varying attitudes in the routine handling of patients. We have also a fairly large representation of the all-sufficient type of country practitioner turned urban who cordially hates the thought of referring his patient to any specialist for any consideration.

My reason for doubting if, in the eyes of the average practitioner—and naturally, therefore, in the eyes of his patients—the roentgenologist is a doctor is based on the impression fostered by the remarks and comments I have heard from day to day. More and more patients enter my office with the unflattering request, "Dr. So-and-so told me to come here and have you make a picture and he will call and see it to-morrow." And later, "Why do you charge so much more than they charge for other pictures?" And, "I simply can't understand

why I should have to pay for a picture and then let you keep it yourself."...etc., *ad nauseum*.

Such remarks are too often a reflection of the comments of the patient's physician. And then there is the little drama of "showing the patient his trouble on the film." Recently a prominent medical journal has been displaying among its advertising columns an appealing cut of a prosperously rotund internist pointing out things on the x-ray plate to his patient. The inference is, "Here is your trouble, Madam. I fear we must resort to surgery." The idea the advertisers very cleverly put over is, "Doctor, you can sell bigger and better operations if you use Blanko Films." I have witnessed this little drama many times of late and listened to accompanying sales talk. Needless to say, it reduces the x-ray specialist to a rather inferior position.

On the staff of the hospital where I have headed the x-ray department for nearly a decade are ten or fifteen loyal friends who, in pathological conferences or staff meetings will rise and say: "Dr. X, of the X-ray Department, will tell us something about the findings in this case and discuss the films." On the other hand, I frequently sit and fume with indignation while some nice new intern or one of the forty other staff members announces, "We had some pictures made and they didn't seem to show much. They're here if anyone cares to look them over."

Now these observations are not, as the reader may suspect, an indication of either wounded professional vanity, financial disappointment, or paranoid tendencies on the part of the author. They are honestly cited as an indication of a general attitude among the medical profession. It is my sincere opinion that in this locality, and probably in others similarly situated, a technical specialist does not obtain the degree of professional respect due a man



with an M.D. degree. Possibly in cities of this size the research or technical side of medicine occupies a relatively unimportant position. Undoubtedly, the salesman from the big manufacturing concerns does much in the way of spreading false doctrine to the effect that anyone can do x-ray work. Certain specialists, notably the urologist, the oto-laryngologist, and the orthopedist, have become proficient in the use of x-ray as regards their particular fields. The tendency therefrom is not favorable to the roentgenologist. It also occurs to me at times that just possibly we are overstocked with specialists in the United States. It might be a good idea to bow to public psychology and set up a new professional classification by which the title "Dr." is reserved for only the most erudite of internists and surgeons.

I see no immediate remedy for this apparent lack of prestige on the part of technical medicine; neither do I think that total absorption of the specialty of roentgenology will take place as has been suggested. One conclusion, however, is obvious: The trustees of a hospital with their unrelenting interest in financial advantages are sure to interpret this attitude of staff members in general as a signal to go ahead and place the x-ray laboratory on a clock-punching basis. This has already been done in some hospitals and will undoubtedly progress until the general practitioner takes a definite stand to the contrary.

Q. B. CORAY, M.D.

Many radiologists, both young and old, will sympathize with the writer of the above letter because all have to contend with the same problem to a greater or lesser degree. May we point out, without any inclination to preach, that the cure for this problem, like many others which the radiologist must solve, is in his own hands. It is true that it will require a long time to effect even a partial cure because the disease is due to ignorance and the only cure for ignorance is a long-continued process of education. Radiology is a young branch of medicine but we frequently must recall the old aphorism that "Life is short, the art long." With some men life will always be too short to acquire even a moderate proficiency in the difficult art which is medicine, and what they call experience will be only a succession of repeated mistakes.

The only possible solution for our correspondent's difficulty is a continuous and patient program of education of our fellow-prac-

tioners who do not appreciate the value and possibilities in the field of radiology. We have a profound confidence in the final triumph of truth. As the radiologist, year in and year out, demonstrates to his colleagues in other branches of medicine his ability to help to solve their problems, their patronizing attitude will gradually disappear and there will remain no question in their minds that the radiologist is an honored practitioner of medicine.

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## ANNOUNCEMENTS

### THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY

The completed report of the Inter-Society Committee for Radiology is published in the April 30 issue of the *Journal of the American Medical Association*, page 1470. We regard this as an important activity in the work of the Committee, and urge all radiologists to study the finished report.

This report should be of some influence in protecting radiologists against unfair demands by hospital groups. The staff of the Bureau of Medical Economics deserves the commendation of all radiology for its straightforward and thorough appraisal of the situation.

Reprints of the report are available upon request to the Executive Secretary, Mr. Mac F. Cahal, 2561 North Clark Street, Chicago.

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## INSTRUCTIONAL COURSES

### NEXT ANNUAL MEETING, PITTSBURGH

One of the ideals of the Radiological Society of North America has always been to give as much instruction in modern radiological methods and clinical medicine as possible. This has been carried out by scientific papers, clinics, and scientific exhibits at our annual meetings. RADIOLOGY is our official printed effort in this direction and by original articles, editorials, and abstracts of the world's radiologic literature helps to keep our membership abreast of the latest developments in radiology.

This year, at the Annual Meeting, a further effort will be made in this direction. Definite courses of instruction, especially along fundamental lines, will be offered. You will recall that the need for such courses was suggested

by Dr. John D. Camp last year in his Presidential Address under the name of "Refresher Courses."

These courses will be similar to those given so successfully by the American Academy of Ophthalmology and Otolaryngology, that devotes approximately half of the entire time of its meeting to these courses of instruction. The success of our courses this year will determine what place they will occupy in our future meetings.

These courses will be given during the entire day, Sunday, November 27, and from 8 A.M. to 10 A.M. on Monday, November 28. They will be under the direct supervision of the Publicity and Educational Committee, of which Dr. Lewis G. Allen is Chairman. The courses will be given by men of recognized ability and should prove to be of great value to those who are fortunate enough to be able to attend. Further details will be given later.

HOWARD P. DOUB, M.D., *President*

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#### EDITOR'S NOTE

With this new volume, a slight change is being introduced in the style of printing references in bibliographies, abstracts, etc.: first, the volume, in black face type; then the page, and lastly the date. In the first numbers of the volume, some references will be found in both the old and the new style. That is the Scotch in us—why go to the expense of resetting standing matter? Both styles are equally clear to the readers, we are confident, but we desire to conform closely to the style of the Cumulative Index Medicus, with which all of our readers are familiar.

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## BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgement of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**THE RADIOLOGY OF PULMONARY TUBERCULOSIS.** By J. E. BANNEN, M.D., Ch.B., D.M.R.E., Hon. Radiologist, Hull Royal Infirmary; Radiologist, Hull Corporation Hospitals and Tuberculosis Clinics, Hull Corporation Mental Hospital, Willerby, Hull and Sculcoates Dispensary. A volume of 156 pages, with 39 illustrations. Published by William Wood & Company, Baltimore, 1938. Price: \$4.50.

**PRAXIS UND ERGEBNISSE DES KURZWELLENHEILVERFAHRENS BEI ALLGEMEINTHERAPEUTISCH RESISTENTEN ERKRANKUNGSFORMEN** (Review of Short Wave Therapy). By DR. L. H. STIEBÖCK, emer. polikl. Assistent, ehemaliger Chefarzt des chirurgischen Spitals des Deutschen Ritterordens in Friedau. Reprinted from "Ergebnisse der gesamten Medizin" (Review of General Medicine), Volume 22, 1937-1938. Edited by Dr. Th. Brugsch, vordem Direktor der medizinischen Klinik der Universität Halle a.d.S. Published by Urban & Schwarzenberg, Berlin.

**TRAITÉ D'ÉLECTRO-RADIOTHÉRAPIE** (Treatise of Electro-radiotherapy). By L. DELHERM, Electroradiologist des Hôpitaux de Paris, Chef du Service central E. R. de l'Hôpital de la Pitié (Paris), and A. LAQUERRIÈRE, Electroradiologist des Hôpitaux de Paris, Professeur à l'Université de Montréal (Canada). Editors: H. Morel-Kahn, Electroradiologist des Hôpitaux de Paris, Chef adjoint du Service central E. R. de l'Hôpital de la Pitié (Paris), General Secretary: H. Fischgold, Assistant d'Electroradiologie des Hôpitaux de Paris (Hôpital de la Pitié), Assistant Secretary. Two volumes consisting of 2,018 pages with 450 figures. Published by Masson et Cie, Paris, 1938. Price: 480 fr., cloth, bound.

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## BOOK REVIEWS

**CLINICAL ROENTGEN THERAPY.** Edited by E. A. POHLE, M.D., Ph.D., F.A.C.R., Professor of Radiology, Chairman, Dept. of Radiology and Physical Therapy, University of Wisconsin. Foreword by GEORGE W. HOLMES, M.D., Professor of Roentgenology in Harvard Medical School, Boston. A volume of 819 pages, illustrated with 199 engravings and a colored plate. Published by Lea & Febiger, Philadelphia, 1938. Price: \$10.00.

In this volume, a complement to "Theoretical Principles of Roentgen Therapy," Pohle has edited a series of chapters written by recognized experts on the various clinical phases of roentgen therapy with the idea of offering to the radiologist helpful advice and suggestions in his daily work and to offer to the beginner a guide in the treatment of those conditions which have been found to be amenable to radiation. For these reasons the book is a practical one, and, as Holmes points out in his Foreword, until Dr. Hickey and Dr. Pohle undertook the production of this text, no serious attempts had been made to write a comprehensive text-book on roentgen therapy in English.

As one casually thumbs through this book, first noting the imposing list of contributors, then the space devoted to each of the chapters

on treatment, glances at the illustrations, and eyes over the bibliographies, one feels that here indeed must be the solution to the long-recognized need of a worthwhile text on radiotherapy. I must admit that after carefully and critically reading this book my offhand opinion about its excellence was well confirmed. The method of presentation of the subject matter by the various authors is admirable—in fact, exemplary. Pohle has edited these various chapters wherever it seemed to have been indicated, and to the composite practically nothing can be added. One ponders in vain to invent an improvement in the whole setup of this volume. In summary, having conscientiously read this book and many others of the same general purport and having reviewed them in this and other journals, I would only state that since this is almost my ideal of a text on radiotherapy I can recommend it without the slightest reservation as the best text on radiotherapy.

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ANALES DEL CENTRO DE INVESTIGACIONES FISIOLÓGICAS. (For the year 1936.) Edited by PROFESSOR ROQUE A. IZZO. A paper of 526 pages, with numerous illustrations. Buenos Aires: Pabellon "Las Provincias," Hospital Tornú, 1937.

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This volume is a collection of papers from the workers in the Institute of Professor Izzo, in Buenos Aires, and it presents their experiences with various aspects of tuberculosis. Therefore, it merits the serious attention of those whose work lies in any of the many fields of this disease. Because of the space necessary to do so, it seems impossible to abstract or criticize the many chapters in this volume. It is suggested, therefore, that it be consulted in the original, an easy task, because each chapter is summarized in Spanish, English, German, and French.

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## IN MEMORIAM

ROBERT HUGHES MILLWEE, M.D.

Word has been received of the death of our fellow-member, Dr. Robert H. Millwee, whose home has been in Dallas, Texas. His wide experience and scientific attainments have made him known, however, far beyond his immediate locality, and he was an honored member of many medical and scientific societies beside the Radiological Society of North America.

A fitting sketch of Dr. Millwee's career is being prepared for the next issue.

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# ABSTRACTS OF CURRENT LITERATURE

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S. M. ATKINS, M.D., of Waterbury, Conn.	L. W. PAUL, M.D., of Kansas City, Mo.
S. RICHARD BEATTY, M.D., of Madison, Wis.	ERNST A. POHLE, M.D., of Madison, Wis.
L. G. JACOBS, M.D., of Madison, Wis.	W. A. SODEMAN, M.D., of New Orleans, La.
JOHN G. MENVILLE, M.D., of New Orleans, La.	WILLIAM R. STECHER, M.D., of Easton, Pa.
J. E. WHITELEATHER, M.D., of Memphis, Tenn.	

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## ANEURYSM

Left-sided Bronchial Carcinoma or Aortic Aneurysm? Alexander Strubell-Harkort. *München. med. Wchnschr.*, Feb. 4, 1938, 85, 177-179.

A case report of a locksmith in whom, on the basis of an anterior roentgenogram and a kymogram of the chest, a diagnosis of aortic aneurysm was made. At another institution a diagnosis of tumor was made and verified at necropsy. The author points out some of the difficulties involved, but apparently he does not consider the value of oblique and lateral views important enough for mention.

L. G. Jacobs, M.D.

## ANIMAL EXPERIMENTATION

The Effect of Roentgen Rays on the Erythropoiesis. K. Mardersteig. *Strahlentherapie*, 1938, 61, 107.

Rabbits were given total body exposure to roentgen rays produced at 180 kv., filtered through 0.5 mm. Cu. The F.S.D. was 1 meter up to 100 r and 50 cm. for doses over 100 r. Single doses of 50 r showed a temporary stimulation of the bone marrow. Doses of 250 r produced a brief stimulation, followed by an inhibition of the bone marrow function, after which came regeneration. This initial stimulation is not observed if a single dose reaches 600 r. After doses of from 3,000 to 6,000 r, the bone marrow ceases to function. Daily exposure to small doses continued for weeks led to the same picture as observed during fractional roentgen therapy in man. Following initial stimulation, the erythropoietic function is inhibited; then follows regeneration of the bone marrow. Irradiation of blood samples *in vitro* with doses of 50, 100, and 300 r did not show any effect on the reticulocytes, while doses of from 500 to 1,000 r definitely inhibited the development of the cells.

ERNST A. POHLE, M.D., Ph.D.

## THE BLOOD

X-ray Treatment of Blood Diseases. J. Ducuing, P. Marques, and O. Miletzky. *Jour. Radiol. Electrol.*, June, 1937, 21, 250. (Reprinted by permission from *British Med. Jour.*, Oct. 9, 1937, page 55 of *Epitome of Current Medical Literature.*)

The authors have treated by means of total radiotherapy 11 cases, of which there were five of Hodgkin's disease, five of myeloid leukemia, and one of lymphatic leukemia. They irradiated the whole body by means of two x-ray tubes energized simultaneously. They gave a total maximal dose of 300 r units in from three to four weeks; the maximum dose at a sitting was 25 r units, and the applications were given every second or third day. During the course of treatment the blood should be closely watched, as the danger of the treatment lies in the possibility of causing a leukopenia or thrombopenia rather than an anemia. Leukopenia usually does

not arise in lymphogranulomatosis and in leukemia. The anemia which is always present in these cases does not constitute contra-indication to total radiotherapy; in fact, it is often improved by the treatment. Thrombopenia is more serious, and no cases showing less than 100,000 thrombocytes per cm. should be subjected to the treatment. Cases of lymphatic leukemia are particularly prone to develop anemia and leukopenia as a result of the treatment.

## CANCER (DIAGNOSIS)

Sedimentation Reaction in Different Forms of Cancer, Especially with Regard to its Prognostic Value: Cancer of Breast. P. Jacoby and J. Spotoft. *Hospitalstid.*, July 6, 1937, 80, 811-813. (Reprinted by permission from *British Med. Jour.*, Oct. 23, page 64 of *Epitome of Current Medical Literature.*)

Since 1932 the authors have systematically applied the blood sedimentation test to the patients attending the radium station in Odense, Denmark. This test was employed not only before and during x-ray and radium treatment, but also at the half-yearly or yearly follow-up examinations. Evidently a high sedimentation rate in cancer depends chiefly on the parenteral absorption of proteins derived from inflammatory reactions and necroses of newgrowths, and not on their actual size or rate of growth. The sedimentation test is, therefore, of little value in diagnosis or differential diagnosis. In the authors' experience it is of great prognostic value. Putting the limit between the normal and a high sedimentation rate at 15, they applied this test to 59 cases of cancer of the breast before any treatment had been instituted, and they found that in the first stage of the disease this rate was almost invariably normal, whereas in the third stage it was normal in only seven and high in 15.

As the sedimentation test is apt to undergo considerable fluctuations during treatment, the authors have studied its behavior 12 months or more after the institution of treatment, and have found a remarkable difference according to whether the patient had or had not developed metastasis. Of 51 patients treated for cancer of the breast and subsequently showing no objective or subjective evidence of disease, the six who had been symptom-free for more than 60 months all showed a normal sedimentation rate; and the shorter the interval of freedom from symptoms between treatment and the sedimentation test the lower was the proportion of cases in which it was normal. Nearly all the patients developing metastases secondary to cancer of the breast showed a high sedimentation rate; indeed, among 39 patients with such metastases it was normal in only two. Hence the authors' conclusion that when the sedimentation rate is consistently high in a patient who has been treated for cancer of the breast, the prospects of recurrence of the disease are great.

## CANCER (THERAPY)

The Treatment of Cervix Carcinoma in the Small

Hospital. G. Frommolt. München. med. Wchnschr., Feb. 18, 1938, 85, 241, 242.

Due to various imperfections in the staff and equipment of small hospitals, the author prefers operation for operable cases. He discusses the results after various operations. The fact that he reports operative mortalities ranging from 6 to 50 per cent for various operations is, in itself, sufficient commentary.

L. G. JACOBS, M.D.

## DIABETES

Functional Irradiation of the Hypophysis: Insulin-resistant Diabetes. L. Delherm and H. Fischgold. Bull. et mém. Soc. de Radiol. méd. de France, October, 1937, 25, 611-619.

There are many cases of diabetes, particularly those associated with other syndromes such as acromegaly and Basedow's disease, which become, it appears, resistant to insulin. These cases can be given enormous quantities of insulin without relief of symptoms. The authors find that in many of these cases irradiation of the hypophysis reduces the tolerance to insulin to a point at which the cases can be carried along comfortably on small or moderate amounts. They discuss the relationship of the pituitary to diabetes. They believe that one of the secretions of the pituitary certainly counteracts the influence of insulin and that a reduction of this activity results in a diminished requirement for insulin in diabetics. The dosage given varies from 1,200 r, given to three portals, to 4,000 r, given to three portals. The results have been very satisfactory in reducing tolerance to insulin and they regard this markedly increased tolerance as an indication for radiotherapy of the pituitary region. They warn that immediately after the discontinuance of irradiation there are apt to be rather grave symptoms. The method is preferable to surgical intervention.

S. R. BEATTY, M.D.

## GALL BLADDER (NORMAL AND PATHOLOGIC)

Fractional Oral Cholecystography. J. Masson. Jour. de radiol. et d'electrol., November, 1937, 21, 494-498.

Cholecystography is a valuable addition to the armamentarium of those interested in diagnosis of abdominal conditions. In the author's experience the fractional oral method has given excellent results, and he feels that routine intravenous cholecystography is unnecessary and should be used only after oral cholecystography has failed.

S. R. BEATTY, M.D.

Doryl Merck (the Hydrochloride of Carbaminoylcholine Ester) as a Means for Initiating a Gall-bladder Contraction. Paul Grüneis. München. med. Wchnschr., Feb. 4, 1938, 85, 181-183.

In order to do a gastro-intestinal study and cholecystography the same day, the author tried to obtain gall-

bladder contraction by some agent administered parentally. Such an agent was Doryl. Contraction occurred in all cases in which it could be induced by a fat meal. The dose was 0.25 mg. of active substance. The contra-indication is any condition in which a sudden marked fall of blood pressure is dangerous, as in cardiac decompensation, Stokes-Adams syndrome. Untoward reactions were not observed. By inserting duodenal sounds, almost pure bile could be obtained by this drug.

L. G. JACOBS, M.D.

## HEMOPTYSIS

Radiology of Hemoptysis. W. Schmidt and K. Unholtz. Ztschr. f. Tuberk., 78, 1-24. (Reprinted by permission from British Med. Jour., Oct. 9, 1937, page 55 of Epitome of Current Medical Literature.)

Schmidt and Unholtz have x-rayed 151 cases of hemoptysis, mostly of tuberculous origin. The patients were filmed in bed immediately following cessation of bleeding, and again later when convalescent. In one-third of the cases no clinical or x-ray changes could be found. In the remainder shadows due to massive aspiration of blood or secondary inflammatory changes were seen. They were of considerable assistance in determining whether the underlying condition was in the process of healing, stationary, or progressive. Evidence of hematogenous dissemination of tuberculosis was well marked. By means of roentgenograms it was possible to ascertain the course of the disease, its distribution, and the course of the focal pneumonias following hemoptysis, even in the absence of physical signs. Changes of non-tuberculous origin were differentiated only by the absence of the specific organism.

## INFECTION

Pseudo-cancer of Recto-sigmoid of Amebic Origin. Uzac and L. Timbal. Arch. d. mal. de l'app. digestif, November, 1937, 27, 986-988.

The authors report a case of pseudo-cancer caused by infection with *B. melitensis*. Both the radiologic and proctoscopic examinations gave the appearance of cancer in the judgment of the investigators.

S. R. BEATTY, M.D.

## INFLAMMATORY DISEASE

Roentgen Therapy of Inflammatory Disease. L. Freund. Strahlentherapie, 1937, 60, 19.

In a more or less historical sketch the author points out that he was one of the first radiologists to recognize the benefit of small doses of roentgen rays on the healing of wounds and on inflammatory processes. In the first instance he feels that the connective tissue is stimulated; on the other hand, large doses may prevent the formation of keloids in surgical incisions in individuals with such a tendency. The author assumes a very generous attitude regarding his priority. To him it is more important that his original observations have

been generally accepted, even though they had to be "rediscovered" several times.

ERNST A. POHLE, M.D., Ph.D.

## THE INTESTINES

Functional Disturbances of Small Intestine: Causes, Results. A. Kraft. München. med. Wchnschr., Sept. 17, 1937, 38, 1488-1490.

The author is strongly of the opinion that a considerable quantity of the gas noted in the small intestinal tract is actually not resultant of an obstruction, but rather, causative. A gas bubble can act as a foreign body, causing disturbance in the passage of the fecal column. There is always considerable gas in the small intestinal tract—either swallowed air or gas formed therein—which is quickly absorbed by the bowel and excreted by the lungs. It is common knowledge that hunger, laxatives, and enemas increase the gas content of the intestines. A preliminary examination of the abdomen affords a fair index as to the degree of gas content. The author suggests a photo-electric cell measurement of the fluorescent screen, using thickness and weight of patient as an indicator of percentage of gas content of the bowel.

Heretofore it has been assumed by most observers that gas in the intestinal tract, particularly in the small intestines, is always indicative of some bowel disturbance rather than a cause thereof. Thus, in peritonitis intestinal pneumatosis is explained on the assumption of paralysis of the gut. In every intestinal disturbance the mucosa is somewhat affected, causing a disturbed absorption of gas. But it can be demonstrated how in certain cases a trapped air bubble can hinder passage of a barium meal, provoking increased peristalsis proximal thereto. Depending upon its intensity or duration, it can cause either increased gastric emptying or, strangely, gastric dilatation with retention. This phenomenon has been repeatedly observed in post-infectious gastro-intestinal complaints, *viz.*, pneumonia, in which case ileus has been suggested; also in gastro-enteritis, over-exertion, dreams, and acute toxic absorption. When meager physical signs and symptoms are present roentgenologically, the condition can be diagnosed, and these cases are frequently under the surgeon's observation for appendiceal disease, or the radiologist's survey for possible peptic ulcer.

From the author's vast experience, he rather dogmatically asserts that too often a peptic ulcer is diagnosed in the presence of mere indirect signs. Inasmuch as gas-ileus and gastro-duodenitis cannot be distinguished at times and are frequently associated, it makes it increasingly difficult to make a definite diagnosis even roentgenologically, unless this new entity is considered. Peptic ulcer and gastro-duodenitis are clinically and roentgenologically difficult to differentiate. The author considers many of the former diagnoses of ulcer as erroneous, if a niche was not demonstrated, and may be well accounted for by the admitted entities of lymphangitis mesenterialis, or gastro-duodenitis. The presence of trapped gas

bubbles can be detected in the erect position in a surprising number of cases, and three typical layers are demonstrable.

The double test meal is advised by the writer, thereby detecting and rechecking the entity if suggestive, by any abnormal distribution of intestinal gas. The author considers gas in the upper small intestines as causative of symptoms as is the more frequently observed colonic and ileal gas. It seems rather incongruous to state that in the presence of a scaphoid abdomen, with no symptoms of meteorism, in the presence of gas in the small intestines, this may be a normal finding.

In summation, the author states that in many thousand gastro-intestinal examinations he is convinced that one of the most frequent causes of acute and chronic dilatation and insufficiency of the stomach is probably resultant of gas-ileus, which can be diagnosed only roentgenologically.

W. M. STECHER, M.D.

## THE JOINTS

Roentgen Diagnosis and Therapy of Syringomyelia. E. B. Gurevitch, G. B. Fomin, and P. B. Shklovskaja. Am. Jour. Roentgenol. and Rad. Ther., September, 1937, 38, 415-426.

Of 128 cases, 73 per cent showed trophic disturbances. The most frequent involvements were in the phalanges and joints (75 per cent), wrist (6.5 per cent), elbow (15 per cent), and shoulder (3.5 per cent). This discrepancy in location and frequency of bone changes, according to other authors, is due to failure of thorough skeletal study in these patients.

Both productive and destructive changes occur, the former minimal, as mushroom-like spreading or sharpened edges of the distal phalanges. The destructive changes may be slight to marked. Various types may occur in one patient and do not necessarily parallel the clinical symptoms. Dislocations, ankylosis, small or large bone deposits may occur in or outside of the joint. Fractures frequently occur, at times unknown to the patient. These are usually transverse fractures and are united by large amount of callus that extends considerably beyond the fracture, either scattered or smooth spindle-shaped.

Radiation treatment resulted in undoubted improvement in 68.6 per cent; there was no change in 30.9 per cent; one patient grew worse. The roentgen prescription was: 185 kv., 4 ma., 0.5 mm. Zn plus 3.0 mm. Al filter. This was applied in 50 per cent erythema doses through 8 × 15 cm. fields, over and moderately beyond the involved area of the spinal cord, in seven or eight sittings, one per month. Sensory improvement was the most frequently noted; next in percentage followed increased muscle power, disappearance of pain, improved motor function, diminution of parasthesia, and diminution of atrophy. The biologic reason for improvement by radiation is probably a diminution of the glial hyperplasia and thus diminution of the pressure on the nerves.

S. M. ATKINS, M.D.



Unilateral Micrognathia: A Rare and Interesting Congenital Deformity. Castay. Bull. et mém. Soc. Radiol. Méd. de France, February, 1937, 25, 125, 126.

The author presents a case of unilateral micrognathia involving both the superior and inferior maxillæ on the right in an 11-year-old girl.

There is partial ankylosis of the temporo-mandibular joint, the patient being able to open her mouth only 1.5 cm. The lesion is probably congenital.

S. RICHARD BEATTY, M.D.

## THE KIDNEYS

Radiation Therapy of Tumors of the Renal Parenchyma in Adults. Archie L. Dean, Jr. Jour. Urol., March, 1938, 39, 303-313.

The following criteria of external irradiation in tumors of the renal parenchyma in adults may be used by urologists: (1) External irradiation alone cannot be relied upon to cure these tumors; (2) pre-operative irradiation will probably decrease the size of these tumors; (3) external irradiation will not make an inoperable tumor operable; (4) pre-operative irradiation may practically prevent the dissemination of tumor cells during a nephrectomy; (5) metastasis may occur while waiting for the full radiation effect of pre-operative irradiation; (6) if a renal tumor is only partially removed, post-operative irradiation may slow the recurring growth but will not stop it; (7) there is a great difference in the radiosensitivity of metastasis.

Using 200 kilovolt units the following pre-operative cycle is suggested: three skin portals, anterior, lateral, and posterior, each about 10 by 14 cm. in size; a target-skin distance of 70 cm.; filtration of 2 mm. of copper; a daily dose of 250 r to a skin portal, and, with the portals treated in turn, a total of 2,500 r to each portal. When this dose has been given, the region of the renal pedicle in a man weighing about 150 pounds will have received approximately five threshold erythema doses. If the patient is thinner, the tumor dose will be proportionately greater. This cycle consists of 30 treatments and requires about a month for completion. If nephrectomy is performed at the end of this time, there should be no appreciable delay in the healing of the wound.

Just before nephrectomy the function of the more normal kidney should be determined as well as the presence or absence of metastasis. In inoperable or post-operative cases a maximal tumor dose is required and the time required is not so important. Four portals are treated, and practically all of the skin covering the side of body at the kidney level is used. Each portal is irradiated once in four days, and 3,000 r may be given each portal. In a 150-pound man, the renal pedicle receives more than 7 T.E.D. This cycle may be repeated in favorable cases and after a suitable rest period. All factors of diagnosis, treatment, and end-results should be critically studied whenever radiating a tumor of the adult renal parenchyma.

JOHN G. MENVILLE, M.D.

Malignant Tumors of the Kidney in Children. Herman L. Kretschmer. Jour. Urol., March, 1938, 39, 250-275.

A report of seven cases of Wilms' tumor. The tumor is characteristic in that it is essentially a disease of infancy and childhood; it runs a silent and rapid course; has a characteristic and unique histological picture; is generally fatal, and there is a multiplicity of theories regarding its pathogenesis.

A thorough review of the pathogenesis, symptoms, sex, diagnosis, and treatment is given. Deep x-ray treatment was given pre-operatively in five cases: a response was noted in all but one. All cases were given deep x-ray therapy post-operatively. Of the seven patients, two are living, three years four months, and two years six months, respectively; the remaining five patients are dead.

The majority of authors favor pre-operative radiation and nephrectomy in the treatment of Wilms' tumor.

JOHN G. MENVILLE, M.D.

Calcification of Renal Tumors and its Relation to Prognosis. George F. Cahill and Meyer M. Melicow. Jour. Urol., March, 1938, 39, 276-286.

A report of 12 cases of calcification in carcinomas of the renal parenchyma demonstrable by x-ray and pathologic study. There were two additional cases not operated upon. It is estimated that 15 per cent of the above tumors present calcification. The authors are of the opinion that a hemorrhage, necrosis, and calcification in parenchymal carcinomas are frequently associated with or are followed by metastatic dissemination. Their results indicate that the prognosis of tumors with calcification is less encouraging than of those without calcification.

JOHN G. MENVILLE, M.D.

## THE KNEE JOINT

Cure of a Bilateral Osteochondritis Dissecans of the Knee. P. Decker. Schweiz. med. Wchnschr., March 5, 1938, 68, 221-223.

The evolution of this disease is in two periods. The first is symptomless, and if perchance roentgenograms are taken, they show a radiolucent spot in the bone under the articular cartilage, with a radiopaque spot in the center. Anatomical examination at this stage shows marked changes in the articular cartilage with detachment from the subjacent bone. A cavity with a piece of more or less detached bone beneath this accounts for the roentgen appearance.

In the second stage the piece of bone is discharged into the joint as a loose body. The lesion is most common in the knee on the external aspect of the internal condyle a little behind the inferior pole. The best roentgenograms are thus obtained with the knee slightly flexed. The lesion is sometimes bilateral. Other joints may be involved.

Three theories of origin are considered; arterial embolus, trauma, and constitutional defect. While none of these is very well substantiated, a case in which complete anatomical cure occurred favors a traumatic origin. Such a case, in a boy 14 years of age, is reported, spontaneous recovery in both knees from such a lesion over a period of about 20 months being observed.

L. G. JACOBS, M.D.

## LYMPHATIC SYSTEM

**Congenital Lymphatic Diseases—Lymphangiomas.** A. O. Singleton. *Ann. Surg.*, June, 1937, 105, 952-968. (Reprinted by permission from *British Med. Jour.*, Aug. 21, 1937, page 29 of *Epitome of Current Medical Literature.*)

Singleton divides lymphangiomas into three types: simple or capillary, cavernous, and cystic. The first of these occurs superficially, and is easily diagnosed and removed. Cavernous lymphangiomas consist of a framework of connective tissues in which there are numerous single and communicating lymphatic cysts. There are also many anastomosing channels, irregular masses of lymphocytes, lymph nodes, and lymph follicles. These tumors are found in the neck, axilla, and groin, and may be so extensive that their removal necessitates major operation. Cystic lymphangiomas are tumors with larger, thin-walled, convoluted cysts filled with lymph and lymphatic fluid. They are commonly found in the neck, and may be present for some time before they enlarge. Lymphangiomas may be found in any part of the body; the most formidable are those within the abdomen, both retroperitoneally within the mesentery of the intestines and in the omentum. In these cases intestinal obstruction is a common complication. Because of the dysfunction of the lymphatic chain, infection is a serious development as it spreads rapidly through the connecting cysts. There are also communications between the cysts and venous radicles, and a blood-stream infection may develop. Excision is the usual method of treatment, and it may be difficult owing to the extent of the process. Radiation, either alone or in conjunction with surgery, is of value. Details are given of 28 cases; operative treatment was carried out in all but two instances, in which radiotherapy alone was applied. In nearly every case recovery took place, and there was a very low percentage of recurrence.

## NEURALGIA

**Dental Trigeminal Neuralgia.** W. Bauer. *Wien. klin. Wchnschr.*, May 22, 1937, 50, 681, 682. (Reprinted by permission from *British Med. Jour.*, July 10, 1937, page 5 of *Epitome of Current Medical Literature.*)

The author distinguishes between true trigeminal neuralgia and the neuralgia caused by dental affections, although this may in its later stages simulate the true trigeminal neuralgia. The main causes of the dental

type are chronic inflammatory conditions of the dental pulp and of the paradental tissues. These affections may give rise to changes in the Gasserian ganglion. In all cases of trigeminal neuralgia a thorough examination of the teeth and jaws is indicated, particularly by means of radiology. The dental trigeminal neuralgia usually subsides after the affected teeth have been attended to; on the other hand, a very severe trigeminal neuralgia may follow a dental operation in an otherwise healthy patient. These neuralgias, however, are usually cured in from three to fourteen days; x-ray treatment combined with aconitine therapy may be of value.

## THE NOSE

**X-ray Visualization of the Naso-lachrymal Duct.** George E. Hourn. *Ann. Otol., Rhin., and Laryngol.*, December, 1937, 46, 962-975.

The author describes the anatomy of the naso-lachrymal apparatus in considerable detail. X-ray visualization of the duct may give valuable information in many cases and is necessary, particularly, when operative procedures are contemplated. Beside the usual views in the lateral and Waters positions, he recommends an intranasal film. For this purpose an ordinary dental film is cut down to make a film pack about 2 × 4.4 cm. The nasal chamber is cocaineized and the turbinates shrunk with epinephrin. The film is inserted into the nasal cavity so that the anterior border extends at least 5 mm. anterior to the ventral extremity of the middle turbinate, and with the base of the film over the second bicuspid to the second molar teeth. Lipiodol or lipiodol diluted with olive oil is used as the opaque medium. It is injected into the punctum, using a No. 24 gage needle after cocaineizing the conjunctival sac. In cases with stricture or obstruction of the duct the lower end can be visualized by injecting the oil through the nasal ostium; the technic for doing this is described. Exposures should be made as soon after injection as possible. In exposing the intranasal film the central ray should be directed to pass slightly anterior to the dense superior lateral portion of the superior oblique orbital margin near the zygomatico-frontal suture, medially and caudally at an angle of 25° to the lower end of the lachrymal fossa.

L. W. PAUL, M.D.

## PAIN

**Physiotherapy of Pain (General Considerations).** L. Delherm and H. Fischgold. *Jour. de radiol. et d'electrol.*, November, 1937, 21, 503-505.

The authors consider the physiology of pain and point out that efficacy of electro-radiotherapy, including x-ray therapy, is limited to the peripheral neurone. The mechanism of pain relief from x-ray has not been explained, but the effect is believed to be due to a change

in the state of polarization of the neurone. Pain arising at levels above the spinal ganglia and their paths is little influenced by any type of physiotherapy.

S. R. BEATTY, M.D.

## PHYSICAL THERAPY

Subcutaneous Emphysema Associated with Perforated Peptic Ulcer. Horace McCorkle and Jean Stevenson. *Surg.*, December, 1937, 2, 930-936.

Subcutaneous emphysema arising from injuries to the chest or respiratory passages is a frequent occurrence, but emphysema arising from the gastro-intestinal tract is unusual.

A case is described in which air (gas) was found beneath the diaphragm, over the chest wall on both sides, and in the tissue of the neck following rupture of a hollow abdominal viscus. Various theories are given as to how the gas reaches the subcutaneous tissue from the peritoneum, namely: (1) By diffusion through the parietal peritoneum; (2) by extension along the esophagus and mediastinum to the neck; (3) by extension to the retroperitoneal areolar tissues and thence to the posterior mediastinum. The authors conclude that there is no satisfactory explanation.

J. E. WHITELEATHER, M.D.

## PERITONEAL CAVITY

The Radiological Study of Acute Abdominal Syndromes: Gaseous Distention of the Peritoneal Cavity. L. Bérard and P. Ponthus. *Bull. et mém. Soc. de Radiol. méd. de France*, October, 1937, 25, 657-662.

It must not be forgotten that there are cases in which the peritoneal cavity rather than the visceral cavities is distended with gas, giving an appearance not at all similar. Peritoneal distention is differentiated from pneumoperitoneum by the gross amount of free gas. The etiology varies. Several case reports are included by the authors, illustrating cases of peritoneal distention, in one of which the cause for the condition was not found. In all cases of acute abdomen without an established diagnosis, radiography is indicated.

S. R. BEATTY, M.D.

## PNEUMOTHORAX

Spontaneous Pneumothorax. M. R. Castex and E. S. Mazzei. *Arch. méd.-chir. de l'App. Respir.*, 1937, 12, 23-38. (Reprinted by permission from *British Med. Jour.*, Aug. 7, 1937, page 21 of *Epitome of Current Medical Literature*.)

The authors point out that spontaneous pneumothorax may often appear in cases of pulmonary tuberculosis. The condition usually occurs in young men under the age of 30; in the authors' 12 cases, in all of which recovery took place, there were no women. Benign spontaneous pneumothorax may arise when the patient is at rest or as the result of varying degrees of

physical effort. The onset may be insidious or sudden, and the outstanding symptoms are pain and dyspnea, with palpitations, cold sweats, cyanosis, nausea, and vomiting. The intensity and duration of the pain is variable, and it may be localized or radiating. There is usually immobility of the affected side of the chest with diminution or absence of local fremitus, increased resonance, and loss of breath sounds. Radiology is of diagnostic value, as it establishes the extent of the pneumothorax and the degree of pulmonary collapse. The pneumothorax is usually complete when there are no adhesions present. Prognosis is good, the symptoms decreasing in intensity after a few days, and the patient recovering completely by the end of a month. The chief complications are hemorrhage and the simultaneous occurrence of the condition on both sides. Recurrence takes place in from 10 to 20 per cent of cases, in occasionally as often as 14 times. Treatment consists of complete rest, morphine injections to relieve pain, and slow respiration. In cases of circulatory shock stimulants may be necessary, and if acute anoxemia is present it is best to carry out extraction of the air and give oxygen.

## THE PROSTATE

Prostatic Enlargement. G. H. Schneider. *Med. Welt*, May 15, 1937, 11, 679-681. (Reprinted by permission from *British Med. Jour.*, Aug. 14, 1937, page 27 of *Epitome of Current Medical Literature*.)

The author ranges himself on the side of other German writers who have recently praised the x-ray treatment of prostatic enlargement, and he reports 24 successful cases. Beside avoiding the risks of narcosis and operative trauma, the preservation of sexual function is claimed. The dosage is worked out after pelvimetric measurements of sacro-prostatic, pubo-prostatic, and sacro-pubic sagittal distances. The application is in the form of 90 per cent of the erythema dose to a total of 350 to 500 r according to the focal distance chosen; preferably five fields of 10 by 15 cm., one perineal, two parasymphysal, and two parasacral, are used. Before the benefit of the intensive irradiation is registered and the treatment is repeated (often two months), five or six weekly supplementary saturation applications are made, each of 50 to 100 r, from large, distant symphysal or sacral fields. The treatment is to be combined at first with catheterization, and may cause a temporary increase in dysuria. The widespread opinion that advanced cases of prostatic hypertrophy are not radiosensitive is stated to be unfounded.

## RADIATION

Comparative Studies Regarding the Specific Effect of Roentgen Rays. G. Miescher. *Strahlentherapie*, 1938, 61, 4.

The author investigated the effect of light, heat, roentgen rays, and thorium X on the skin of the ear of

guinea pigs and also on human skin. The following sources of radiant energy were used: quartz mercury vapor lamp, a quartz chamber through which was flowing water at the temperature of 50-51° C., roentgen apparatus (doses of 300-120,000 r), thorium X paint delivering alpha rays which were absorbed in 0.1 mm. thickness of tissue. Intensities of 150, 1,000, and 10,000 E.S.U. per c.c. were used. Histological studies were carried out on the excised skin specimen up to the fiftieth day after the application of these various agents. The early heat and light reactions are characterized by cell necrosis and disturbance of the mitosis (pyknosis). This reaction is non-specific and non-elective and appears first in the superficial cells. Regeneration starts within the first few days and is completed within two weeks. From the second to the fourth week numerous cells with double nuclei can be found. The reactions following exposure to roentgen rays and thorium X differ; there is no cell necrosis but only disturbance of mitoses. The late effect consists of abnormal karyokinesis, amitosis, polymorphism of nuclei, and hypertrophy of the entire cell. The principal effect of roentgen rays and alpha rays manifests itself in the nucleus and very little in the plasma; this explains the occurrence of cumulative late effects.

ERNST A. POHLE, M.D., Ph.D.

The Reducing Effect of Roentgen Rays on Redox Dye Indicators. W. Seitz. *Strahlentherapie*, 1938, 61, 140.

Dyes which belong to the group of Redox indicators are discolored when exposed to roentgen rays in a watery solution; the process is reversible. The author demonstrated this phenomenon with 17 different dyes. While this reduction process occurred without exception, oxidation can never be produced under any condition. The author discusses at length the mechanism of this phenomenon and considers its application to a hypothesis of the effect of radiation. In his opinion, part of the effect of roentgen rays is due to a reducing process, chemically speaking, which is caused by the electrons freed during irradiation.

ERNST A. POHLE, M.D., Ph.D.

## RADIATION INJURIES

Cancer Developing in Accidentally Produced Radiodermatitis. S. Laborde. *Rev. de Physiothérapie*, March-April, 1937, 13, 89-99. (Reprinted by permission from *British Med. Jour.*, July 24, 1937, page 15 of *Epitome of Current Medical Literature*.)

Laborde points out that although the occurrence of cancer in radiologists has long been known, cases of cancer formation following the therapeutic administration of x-rays are infrequent owing to the fact that patients are rarely subjected to graduated applications over a sufficiently long period. He reports four such cases occurring 11, 15, 18, and 21 years after treatment, in all of which histologic examination showed a spinomedullary epithelioma. The first case had had nu-

merous applications over a period of four years for eczema of the hands, the second several applications for hair on the face, the third x-ray administration to the spinal column for paraplegia, and the fourth 15 applications over two years for facial angioma. The first patient was cured by amputation, the second by three applications of radium, the third is becoming worse in spite of radium therapy, and the fourth died. Laborde points out (1) that chronic radiodermatitis produced by whatever type or quality of irradiation is a precancerous lesion; (2) that although the causal factor after a long latent period was in each case x-ray administration, nothing is known of the nature of the phenomenon which suddenly produces malignant growth in tissues, modified in structure and physiology after so many years; (3) that cicatrization and cure may follow the application of radium provided that the cancer is surrounded by sufficient healthy tissue, for the radiosensitivity of cancers depends on the action of the rays on the neoplastic cells and on the medium in which they develop.

Irradiation Sarcoma. Harwell Wilson and Alexander Brunswick. *Surg.*, October, 1937, 2, 607-611.

Epidermoid carcinoma has been repeatedly observed in skin areas where there has been subcutaneous cicatrization, telangiectasis, and sometimes chronic ulceration due to previous irradiation with radium or x-rays. Irradiation sarcoma has not been frequently reported.

One case which was observed by the authors was a spindle-cell sarcoma developing after 90 x-ray irradiations had been given as treatment to some keloids above the right breast following a burn. Death from metastases followed.

The authors quote from various experimenters who were able to produce irradiation sarcomas in animals in chronically infected areas. They also have collected 25 cases from the literature, all arising from radiation to areas of chronic inflammation: 14 cases were due to treatment for bone and joint tuberculosis. The treatments in all cases were extended over a long period of time and the growths appeared in from three to 24 years.

J. E. WHITELEATHER, M.D.

## RADIUM

The Radiation Emitted by Blood and Other Tissues Following Radium Injections. Van Hove. *Strahlentherapie*, 1938, 61, 300.

The author studied the radium content of the blood following intravenous injection of from 0.01 to 0.03 mg. by means of photographic films. In some cases the radium content dropped very rapidly on the fourth day; in others the drop occurred rather gradually. Even two months later there was still definite blackening of the film. Following subcutaneous injection of radium solutions the radium content of the blood reaches its peak 24 hours later. During the first few days following the injection the adrenals, bone marrow,

kidneys, spleen, liver, lungs, pancreas, and uterus contain radium. Several weeks later it is still found in the liver, spleen, and bone marrow.

ERNST A. POHLE, M.D., Ph.D.

Experiments Regarding the Indirect Ionization by Gamma Rays. H. Smereker and K. Juris. *Strahlentherapie*, 1938, 61, 161.

Observations in the Wilson chamber indicate that ionization by x-rays and gamma rays of radium does not occur direct but *via* the photo and Compton electrons. The authors studied this phenomenon by means of an ionization chamber with very thin walls, using gamma rays of radium. By practically preventing the electrons formed in the filter of the radium and in the air space between radium screen and ionization chamber from reaching the chamber, he could show that the ionization current thus measured is reduced to about 5 per cent of the current measured by means of a chamber with thick aluminum walls.

ERNST A. POHLE, M.D., Ph.D.

Further Results in Determining Radium Doses in r with the Photographic Method. H. Kirchhoff and K. Bartz. *Strahlentherapie*, 1938, 61, 363.

The authors found the photographic method a valuable addition to radium dosimetry. (They described the procedure in detail in "Strahlentherapie," 1935, 54, 462.) In order to imitate conditions existing in practice the measurements were carried out in rice phantoms. Some of the isodose curves obtained with the method are shown in the article. The authors urge the adoption of the r in radium therapy.

ERNST A. POHLE, M.D., Ph.D.

Radium Therapy of Condyloma Acuminatum. J. Körbler. *Strahlentherapie*, 1938, 61, 137.

The author reports a case of a 13-year-old boy who had a condyloma acuminatum of fairly large size on the penis. The author prepared a radium mold which carried 12 radium screens at 1 cm. distance from the skin: six contained 3 mg. and six contained 2 mg., each filtered through 1.0 mm. Pt. The applicator was left in place for 93 hours, giving a total dose of 2,790 mg.-hr. Photographs show the patient before and two months after the treatment. The result was apparently very satisfactory.

ERNST A. POHLE, M.D., Ph.D.

Studies Regarding the Problem of Radium Poisoning. K. Inouye and A. Krebs. *Strahlentherapie*, 1938, 61, 269.

In the third of a series of articles concerning radium poisoning, the authors furnish proof that, following administration of emanation, long-lived disintegration products are deposited in the organism. The organs of preference are bone, bone marrow, spleen, and liver. It appears that following the application of

emanation in solution, radium salts find their way into the organism and are deposited there. The tolerance dose for various disintegration products, especially polonium, was determined and compared with the tolerance for roentgen rays.

ERNST A. POHLE, M.D., Ph.D.

The Danger of Pyometrium in Radium Therapy: How to Avoid. Th. Nogier. *Bull. et mém. Soc. de Radiol. méd. de France*, October, 1937, 25, 646-648.

The presence or formation of a pyometrium during radium therapy prevents the proper treatment of the uterine lesion. The radium is not in contact with the walls equally and some areas are over-dosed and some under-dosed. The author believes that pyometrium can be avoided by pre-operative vaccination, by drains which he has devised to be applied in conjunction with the radium, or by daily removal of the radium and cleansing of the apparatus.

S. R. BEATTY, M.D.

Studies Regarding the Problem of Radium Poisoning. A. Janitzky, A. Krebs, and B. Rajewsky. *Strahlentherapie*, 1938, 61, 254.

The authors continued their studies of radium poisoning and determined experimentally the radium deposits in the human body. By measuring the emanation with a specially constructed Geiger counter they were able to record the absolute amount of radium deposits, the distribution in the various tissues of the body, and the emanation emitted. It appeared that very small amounts of radio-active substances, as little as 1 $\mu$  gram in the body, may suffice to produce irreparable damage. This can be explained by the intense biologic effect produced by the alpha rays which are totally absorbed as well as by the complete cumulation.

ERNST A. POHLE, M.D., Ph.D.

## RECTAL CANCERS

Five Cases of Cancer of Rectum Cured by Roentgen Therapy. E. Bandier. *Ugesk. f. læger.*, July 1, 1937, 99, 714-719. (Reprinted by permission from *British Med. Jour.*, Oct. 9, 1937, page 55 of *Epitome of Current Medical Literature.*)

Bandier endorses with certain reservations the general opinion that the radiological treatment of cancer of the rectum is palliative rather than curative. At the Radium Station in Copenhagen, in the period 1931 to 1934, the admissions for cancer of the rectum numbered 142, but only nine of these cases were considered operable. In 125 cases x-ray treatment only was given, a supplementary colostomy being performed in a few instances. There were 43 deaths during the first year after treatment, 39 during the second year, 15 during the third year, eight during the fourth year, and three during the fifth year. None of the patients who died showed at any time signs of clinical recovery, and in almost every case the cause of death was cancer of the

rectum. In the eight cases in which the immediate cause of death was other than cancer, the tumor of the rectum showed no regression. The author gives details of five cases in which, after microscopical verification of the diagnosis, clinical recovery was achieved under treatment by x-ray therapy alone. The observation period was three years in two cases and five in three. An attempt was made to ascertain what were the factors governing the recovery in these five most exceptional cases, but they appeared to be quite ordinary instances of adenocarcinoma of the rectum. Recovery could not be ascribed to any novel departure from conventional x-ray treatment of cancer of the rectum. The author concludes that while x-ray treatment is incomparably inferior to operative treatment in operable cases, these five recoveries justify further close study of x-ray treatment for this condition.

## THE SHOULDER JOINT

Function of Shoulder Joint after Reposition of Old Luxation of Humerus. C. Van Staveren. *Nederl. Tijdschr. v. Geneesk.*, June 26, 1937, 81, 3035-3037. (Reprinted by permission from *British Med. Jour.*, Sept. 11, 1937, page 38 of *Epitome of Current Medical Literature.*)

The author has treated ten cases of chronic dislocation of the shoulder joint in elderly patients, and obtained good results without operation. In all but one case, in which it was axillary, the dislocation was subcoracoid. The treatment consisted in replacement under an anesthetic by Cooper's traction method. All the cases were subsequently submitted to x-ray examination, and in only one was there any evidence of arthritis deformans.

## THE SPINAL CORD

Spinal Extradural Cyst and Kyphosis Dorsalis Juvenilis. Ralph B. Cloward and Paul C. Bucy. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1937, 38, 681-706.

Extradural cysts are believed to be evaginations of the arachnoid membrane and dura mater at the point of emergence of the spinal roots from the meninges, and produce rounded thoracic kyphosis with a spastic paraplegia. Roentgenologically, enlargement of the spinal canal and erosion of the vertebral pedicles are seen. Depending on the duration of the disease, the bodies also show thinning, especially the anterior corners, which may even be completely absent. The superior and inferior intervertebral borders are frayed and permit the nucleus pulposus to press into them.

Early removal of the cyst, which most commonly occurs in the lower thoracic region, will rapidly relieve the symptoms and stop further atrophy, but in the later stages no such definite relief can be expected.

Although kyphosis dorsalis juvenilis, unassociated with such cysts, may be due to venous congestion and

stasis within the vertebral bodies, nevertheless, they should be considered as a possible cause.

The entire article should be read.

S. M. ATKINS, M.D.

## THE STOMACH

A Large Diverticulum of the Fundus of the Stomach. M. E. Pierron. *Bull. et mém. Soc. de Radiol. méd. de France*, October, 1937, 25, 649-652.

The author presents a case showing a large diverticulum of the fundus. He states that this is a rare finding in his practice. A discussion of the diagnosis is given.

S. R. BATTY, M.D.

The Treatment of Inoperable Carcinoma of the Stomach. H. Regelsberger. *Strahlentherapie*, 1938, 61, 201.

In the author's experience the single massive dose method proved to be unsatisfactory. He developed then a modified Coutard technic (180 kv., 4 ma., 1 mm. Cu; 200 r per hour) and applied if possible one single field, using cross-firing only for very large tumors. The total dose per area amounted to about 4,000 r which corresponded to approximately 3,000 r in the tumor. By comparing the statistics of 44 cases treated with the massive dose method with 35 patients treated with the fractional dose method a great improvement in the results could be noted; about 60 per cent of the second series responded favorably to treatment. In 22 cases a filter of 0.5 mm. Cu and consequently shorter exposure times was used; however, the end-results were less favorable than with the heavier filter. A combination with surgical measures, especially in combating hemorrhage and in suitable cases also serum therapy should be considered.

ERNST A. POHLE, M.D., Ph.D.

Diagnostic Value of Gastric Lavage in Adult Patients without Roentgenographic Foci in Lungs. U. Gad. *Nord. med. Tidskr.*, May 22, 1937, 13, 815-818. (Reprinted by permission from *British Med. Jour.*, July 10, 1937, page 5 of *Epitome of Current Medical Literature.*)

The author has undertaken gastric lavage on two consecutive mornings, using 300 c.c. of water, in 271 patients admitted to a Danish hospital for tuberculosis. All these patients presented no radiological evidence of active pulmonary tuberculosis. In as many as 34 cases tubercle bacilli were found by this means, and the patients were classified in five groups. Out of 97 patients in the first group who were admitted to hospital for observation, although the radiological picture was perfectly normal, there were 11 in whose stomachs tubercle bacilli were found. In the second group of 66 patients there was a history of pulmonary tuberculosis earlier in life, but the radiological picture showed no sign of active disease. The gastric lavage, however,

yielded tubercle bacilli in five of these cases. In the third group of 75 patients suffering from pleuritis there were 12 whose stomachs contained tubercle bacilli, although in none of these cases was there any radiological evidence of a tuberculous focus in the lungs. In the fourth group of ten cases in which the radiologic findings were indicative of hilus tuberculosis, but in which there was no sign of any infiltration of the lungs, there were as many as six whose stomachs contained tubercle bacilli. In the fifth and last group of 23 patients, representing a great variety of morbid conditions such as erythema nodosum, spontaneous pneumothorax, emphysema, bronchitis, etc., there was not one case in which gastric lavage yielded tubercle bacilli. Thus it was only in this last group that the radiologic and bacteriologic tests agreed in being invariably negative. The author concludes that the radiologic examination of the lungs often fails to detect active pulmonary tuberculosis, and that in many cases gastric lavage repairs this diagnostic failure.

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The Value of Gastroscoy in Diagnosis and Surgical Treatment of Chronic Gastroduodenal Ulcer. Rudolph Schindler. Surgery, November, 1937, 2, 692-709.

Schindler points out that gastrophotography is not satisfactory in the diagnosis of ulcer because of the inability to identify the area upon the developed film and the fact that the most sensitive films do not satisfactorily differentiate yellow and red colors, so important in gastroscopy, especially in the diagnosis of ulcer. He considers gastrophotography worthless.

Roentgenologic examination is, on the whole, of greater value than gastroscopy in gastroduodenal ulcer, in contrast to carcinoma and chronic gastritis. Gastric ulcers are sometimes missed by roentgenoscopy, found by gastroscopy, and *vice versa*. Ulcers of the duodenum and of the pyloric canal cannot be seen by gastroscopy. However, a number of advantages of gastroscopy are given, including the demonstration of ulcers not diagnosed by other methods, the ability to follow healing of the ulcer, and the localization of gross hemorrhage.

W. A. SODEMAN, M.D.

## THE THYMUS

A Case of Hypertrophy of the Thymus Treated by Roentgen Therapy in 1911. Th. Nogier. Bull. et mém. Soc. de Radiol. méd. de France, October, 1937, 25, 643-645.

The author presents a case which he treated in 1911 with fairly heavy doses of lightly filtered x-rays. There have been no untoward after-effects. The skin of the neck is absolutely normal.

S. R. BEATTY, M.D.

## TUBERCULOSIS (PULMONARY)

Vitamin C in Hemoptysis. F. Capelli. Riv. di pat. e clin. d. tuberc., May 31, 1937, 11, 317-321. (Reprinted by permission from British Med. Jour., July 24, 1937, page 13 of Epitome of Current Medical Literature.)

The author has found ten daily intravenous injections of 50 mg. of ascorbic acid useful in certain hemoptyses due to pulmonary tuberculosis in a small series of patients. The method failed in two cases of hemorrhage accompanying a new extension of the tuberculous process, proved radiologically, but it appeared strikingly successful in the prevention of regularly recurring hemorrhages in cases of long-standing fibrosis with cavitation, and it seemed effective when other treatments failed in cases of frequent small hemoptyses in those having minimal pulmonary foci of infection. In phthisis there is little alteration of the blood coagulation rate, and the hemostatic action of vitamin C would appear to be attributable to a regulatory effect on adreno-cortical and anterior pituitary hormones, combined possibly with a catalytic action on clotting ferments.

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Systematic Fluoroscopy for the Detection of Tuberculosis in the French Army. J.-J. Didiée. Bull. et mém. Soc. de Radiol. méd. de France, October, 1937, 25, 619-627.

Admitting that fluoroscopy is not as accurate as radiography for detecting early lesions, it has, however, become accepted as a routine method of case-finding in the French army. The convenience of the method, the relative lack of expense, and the rapidity with which large groups of men can be examined rather offset the slight loss of accuracy which can be expected. However, the employment of experienced radiologists and the association of this examination with rigorous clinical examination, produce, it is felt, a very great degree of accuracy in detecting cases of tuberculosis. Those cases in which there is any suspicion of a lesion are subjected to radiography. The technic of radioscopy and the system which has been developed for fluoroscopy of large numbers of men are described in some detail.

S. R. BEATTY, M.D.

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Problem of Tuberculosis, with Special Regard to Question of Isolation. O. Lassen. Ugesk. f. Læger., June 10, 1937, 99, 615-625. (Reprinted by permission from British Med. Jour., Aug. 21, 1937, page 30 of Epitome of Current Medical Literature.)

The author has undertaken an intensive study of the clinical histories of the last 100 patients who died of open pulmonary tuberculosis in the town of Aarhus, Denmark. The average age at death was between 31 and 32, and two-thirds were under 35. The clinical and radiological reports at the time when the diagnosis was first made showed in as many as 78 cases such advanced disease that little hope of recovery could be en-

tertained; and among the remaining 22 cases advanced, but still curable, disease was often found. A study of the institutional careers of these 100 patients revealed that as the disease progressed the duration of hospital or sanatorium treatment became longer, and as all the cases terminated fatally no permanent benefit could be claimed on their behalf for the institutional treatment they had received. Did it benefit the community by the limitations it imposed on opportunities for spreading the disease? The author is inclined to think that these patients did all the harm they could in this respect while they were still leading free and active lives. In Aarhus, 82 per cent of all the deaths from tuberculosis take place in hospital, and though this arrangement certainly ensures that the patients receive good nursing, the author wonders how valuable it is from the epidemiological point of view. He notes in this connection that while the tuberculosis mortality has recently declined in a most encouraging fashion, there is not a corresponding decline in the tuberculosis morbidity.

### TUMORS (DIAGNOSIS)

Roentgen Diagnosis in 94 Cases of Renal Tumor. E. Ross Mintz. *Jour. Urol.*, March, 1938, 39, 244-249.

A report representing pyelographic findings in 94 cases of renal tumor. The tumors were cortical in 82 instances, pelvic in nine, and extrarenal in three. Displacements and defects of the calyx, pelvis, and ureter are tabulated. It is stated that the roentgen picture was just a link in the chain of evidence in making a diagnosis of renal tumor. Equally important are the history and the clinical signs and symptoms.

JOHN G. MENVILLE, M.D.

Adamantinoma of the Lower Jaw. R. Jaulain. *Jour. de Méd. de Bordeaux*, May 29, 1937, 114, 693-703. (Reprinted by permission from *British Med. Jour.*, Aug. 7, 1937, page 21 of *Epitome of Current Medical Literature*.)

Jaulain states that adamantinomas are very uncommon tumors, and are usually found in females over the age of 15. The adamantine epithelioma is most commonly situated on the posterior part of the horizontal ramus of the lower jaw. The first symptom is the gradual but steady increase in the size of the jaw, which causes a progressive deformity of the face. On palpation a fixed tumor can be felt; it may be hard, or, if cystic, fluctuation may be present. There are no functional symptoms in the early stages, and the general condition of the patient is good; diagnosis can be confirmed by radiography. The tumor, if neglected, may become as large as a fetal head, extending downward to the chin. Sometimes the teeth erode the palate and fall out, speech and mastication become difficult, and gradually the general condition declines as a result of toxic absorption. If the tumor is cystic, puncture will draw off a yellow or dark fluid, similar to

that from an intracystic hemorrhage; while if it is hard, radiography will often show destruction of the adjacent bone. Treatment must aim at complete removal, and this may be carried out in the early stages, when the lesion is localized, by curetting. In the case of large tumors extensive resection is necessary in order to prevent recurrence. A careful technic is needed for this operation, but even then bronchopneumonia is liable to develop. A case is reported in which a large tumor was successfully removed, but the patient died from pneumonia on the thirteenth day. Emphasis is laid on the importance of early treatment while the prognosis is still good.

### TUMORS (THERAPY)

Roentgen Therapy of Tumors of the Hypophysis. J. Erdélyi. *Strahlentherapie*, 1938, 61, 241.

The author relates his experience with roentgen rays in the treatment of hypophyseal tumors. During the last 12 years he has treated 40 cases of acromegaly and a recent survey showed that 22 patients are still well and pursuing their occupation. Since 1924, he has observed 61 tumors of the hypophysis: seven of these were operated on; four died shortly after the operation; two improved, and one was not improved. The remaining 54 cases were treated by irradiation: 12 died; 13 could not be traced; 13 remained stationary, and 16 were improved. He used 180 kv., 30 cm. F.S.D., 1 mm. Cu + 1 mm. Al, and single doses of 220 r. A temporal area is exposed as test field and if this is tolerated well the dose is increased in the following two days to 650 r. The other areas are an additional temporal field, one frontal, one parietal, and one occipital area. In this manner he administers approximately 100 per cent of the skin erythema dose to the tumor. In children this total dose is reduced to about 75 or 80 per cent. Care should be taken not to expose the eyes because injuries have been reported following excessive exposure. As a rule all cases are given x-ray therapy first unless intracranial pressure symptoms demand immediate operation. If the patient responds well to the treatment, additional series should be given at intervals of from six to eight weeks. All patients who are operated on should receive roentgen therapy later.

ERNST A. POHLE, M.D., Ph.D.

Direct Irradiation of Cerebral Tumors. C. A. Elsberg, L. M. Davidoff, and C. G. Dyke. *Bull. Neurol. Inst. N. Y.*, January, 1937, 6, 19-32. (Reprinted by permission from *British Med. Jour.*, Aug. 28, 1937, page 35 of *Epitome of Current Medical Literature*.)

The authors have made a preliminary report on the technic and results of the direct application of x-rays to cerebral tumors exposed at operation. Most of the tumors of the glioma group can be only partially removed at operation, their deep subcortical ramifications being untouched. Their sensitivity to x-rays varies enormous-



ly; the posterior fossa medulloblastomas of childhood give a response to deep x-ray irradiation after decompression, which appears to be better than removal, while in others, such as the astrocytomas and the glioblastomas, results are usually disappointing. With present methods not only is the liability to necrosis of the scalp and bone great but the tumor receives insufficient irradiation. In order to eliminate these disadvantages a very high voltage was used, and irradiation of irremovable and partially removable tumors was carried out in the operating theater by direct application of the rays to the cortex through a layer of cellophane. A 200,000-volt, 25 ma., oil-cooled apparatus was used, and an elaborate portable lead screen was arranged in the theater.

In order to establish the maximal safe dose experiments were carried out on monkeys. It was found that over 4,000 r units caused definite neuronal destruction, but 3,000 r units could be used with impunity. Both the cerebrum and cerebellum were irradiated, smaller doses being used for the former as it was found that cerebral symptoms were more readily evoked, although some of the symptoms were very late in onset. In some cases in which no cerebral symptoms occurred there was depilation and bone necrosis on the side opposite the point of entry of the rays.

In the application of this technic to man 18 cases of cerebral tumor were irradiated at operation, and although it is too soon to draw decisive conclusions, the method would seem to justify further trial and study.

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Status of Surgical and Irradiation Treatment of Wilms' Tumor, and Report of Two Cases. Walter H. McNeill, Jr., and Alexander J. Chilko. *Jour. Urol.*, March, 1938, 39, 287-302.

A review of Wilms' tumors and a report of two cases.

The first case was considered inoperable. Several x-ray treatments were given without noticeable improvement, and the child died in five months.

The second case, a 14-month-old child, was diag-

nosed clinically as having a Wilms' tumor, and was treated by x-ray alone. The mass gradually disappeared. During the past three years the child has received 10,319 r of x-ray, has gained 17½ pounds, has a normal blood picture, and shows no skin reaction.

JOHN G. MENVILLE, M.D.

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Radiotherapy of a Mediastinal Tumor. M. Billant. *Bull. et mém. Soc. de Radiol. méd. de France*, October, 1937, 25, 686-689.

The author presents a case with enormous mediastinal tumor treated in 1935 with x-rays. He comments on the use of roentgen rays in the treatment and in the differential diagnosis of mediastinal tumors.

S. R. BEATTY, M.D.

### ULTRA-VIOLET LIGHT

The Treatment of Peritoneal Tuberculosis by Ultra-violet Light. M. Aubert. *Bull. et mém. Soc. de Radiol. méd. de France*, October, 1937, 25, 638-643.

The author presents 35 cases of peritoneal tuberculosis treated with massive doses of ultra-violet light. Out of these, 26 showed clinical cure, five were greatly improved although the full course of therapy could not be given, and four died. He believes that all cases of peritoneal tuberculosis with the single exception of those with pulmonary lesions should be treated with ultra-violet light.

S. R. BEATTY, M.D.

### THE WRIST

A Rare Anomaly of Ossification in the First Row of Carpal Bones. P. Reinbold. *Schweiz. med. Wchnschr.*, March 5, 1938, 68, 242.

A case report of a bilateral synostosis of the lunate and triquetrum, which produced no functional change in the wrist.

L. G. JACOBS, M.D.

# LOCAL COMMITTEES FOR THE TWENTY-FOURTH ANNUAL MEETING

of the

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NOVEMBER 28—DECEMBER 2, 1938

PITTSBURGH, PENNSYLVANIA

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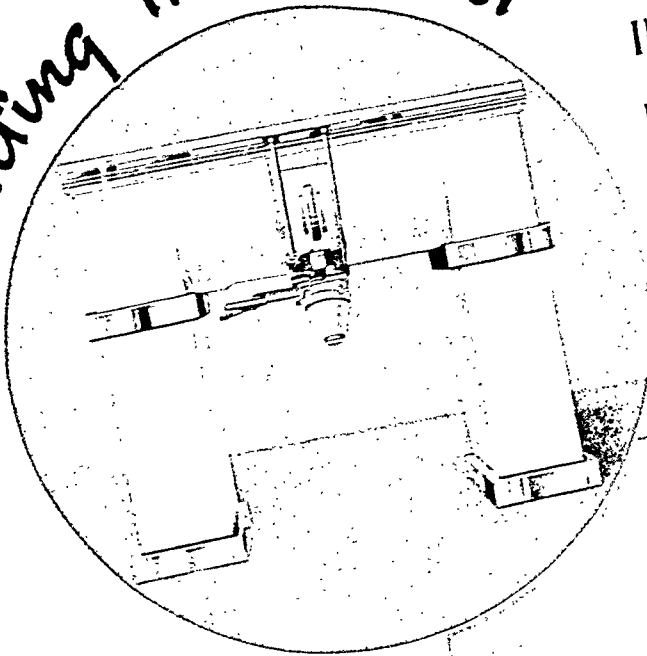


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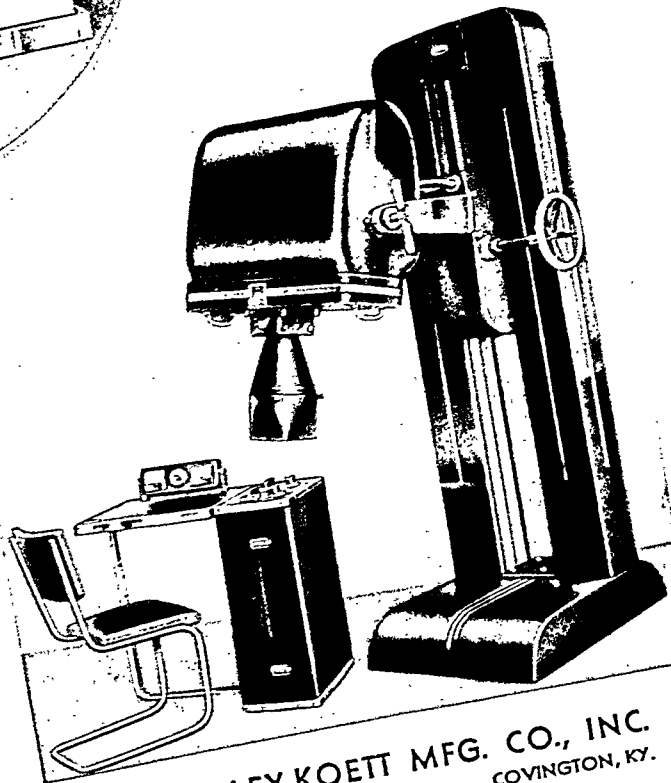
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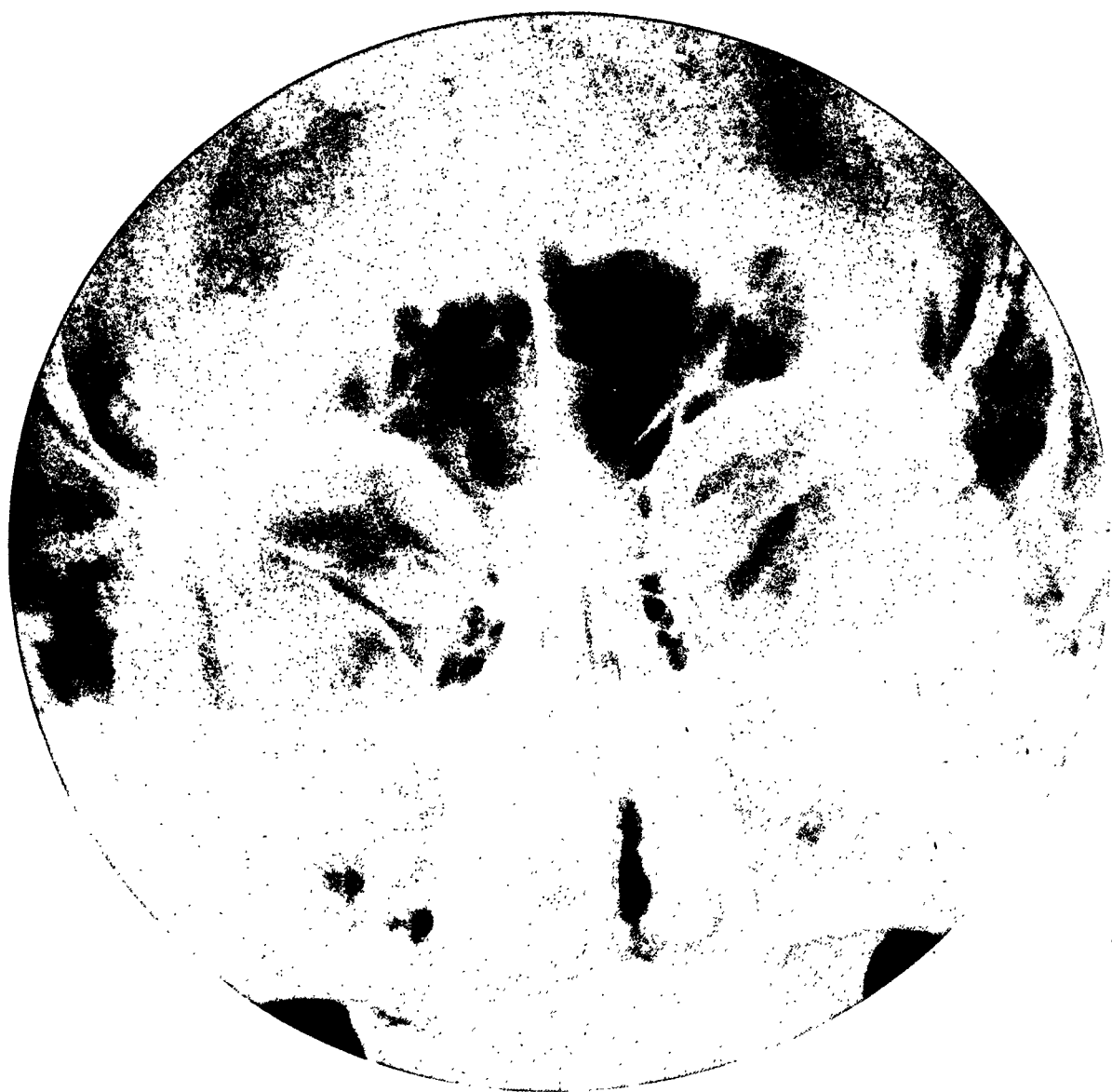
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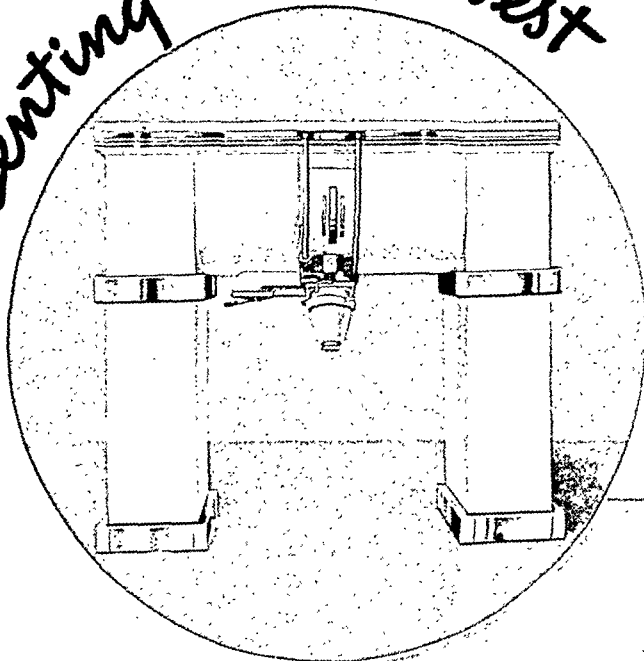


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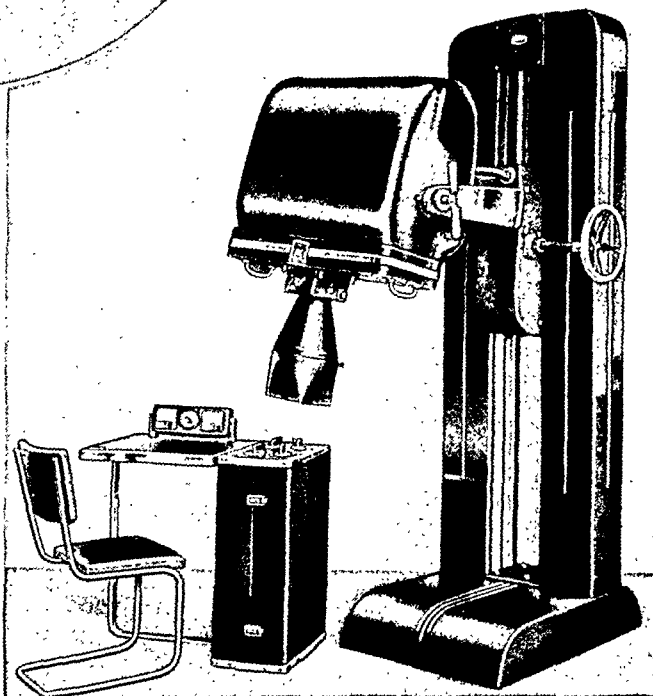
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... ..

.. .. .



***Technical Factors for Radiograph Reproduced on  
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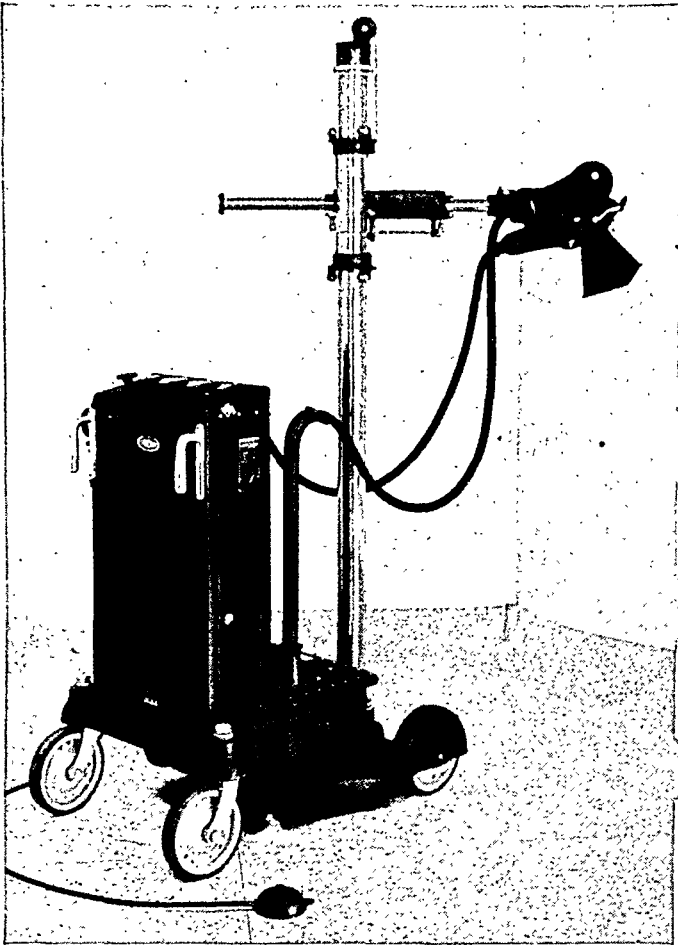
PROJECTION	Postero-anterior	FILM	Eastman <i>Ultra-Speed</i>
THICKNESS	18 cm.	SCREENS	Eastman <i>High-Definition</i>
ANODE-FILM DISTANCE	30"	KV.P.	90
P-B DIAPHRAGM	8-1 grid-ratio	MA.S.	80
TUBE	1.5 mm. focal spot	DEVELOPMENT	Kodalk X-ray
FILTER	1 mm. aluminum		Developer (3½ min., 65° F.)
CONE	3"	FIXATION	Eastman X-ray Fixer

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★★★★ This unit is completely shockproof. The tube is mounted in a shockproof-rayproof casing connected to the high tension system by means of shockproof cables. There are no exposed conductors.

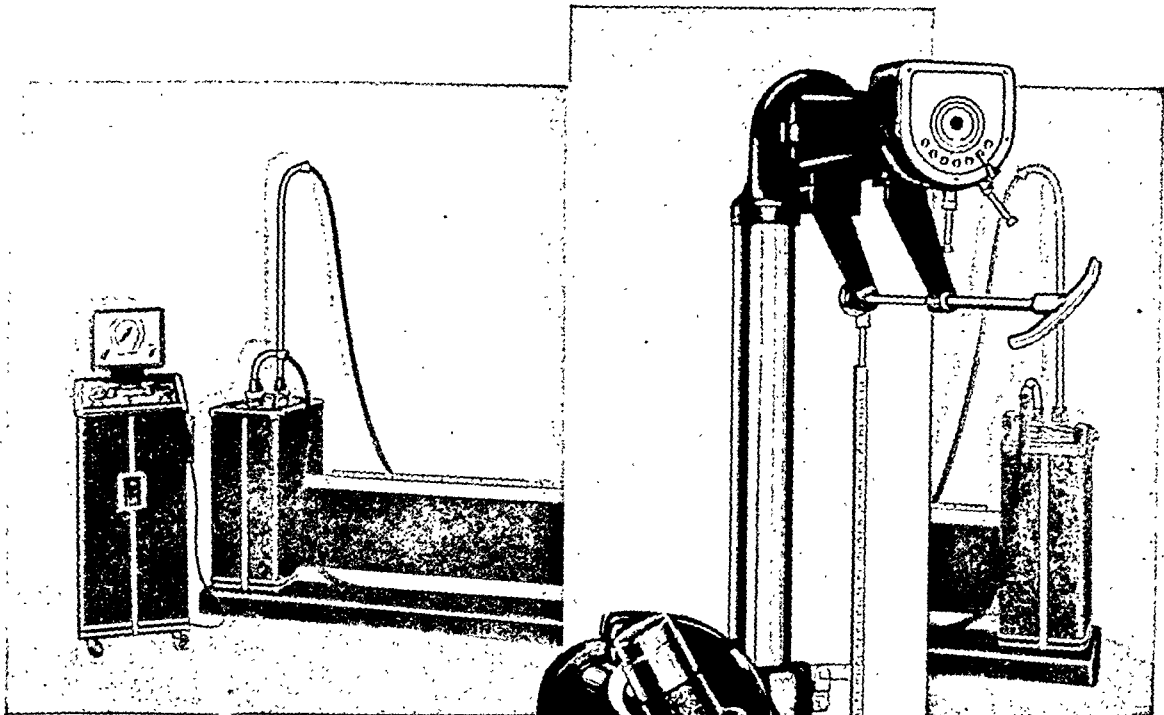
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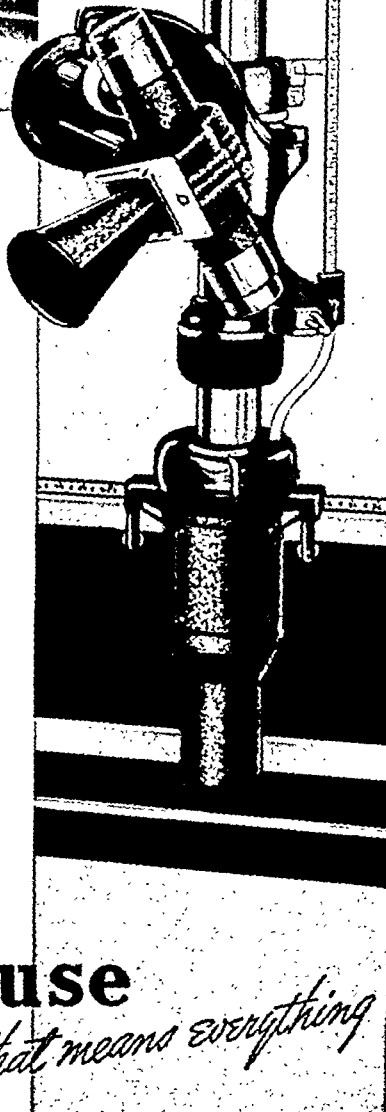
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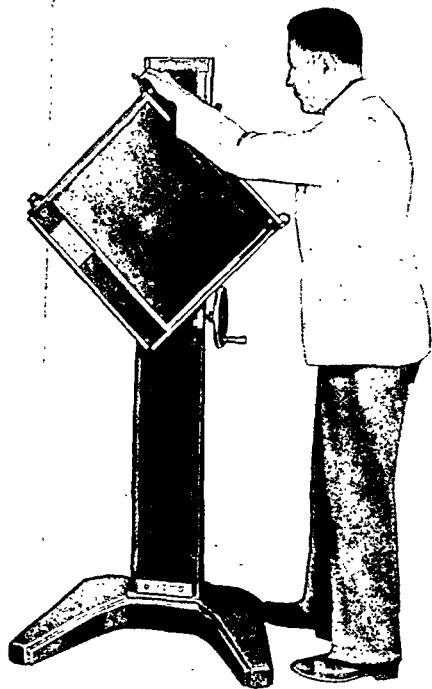
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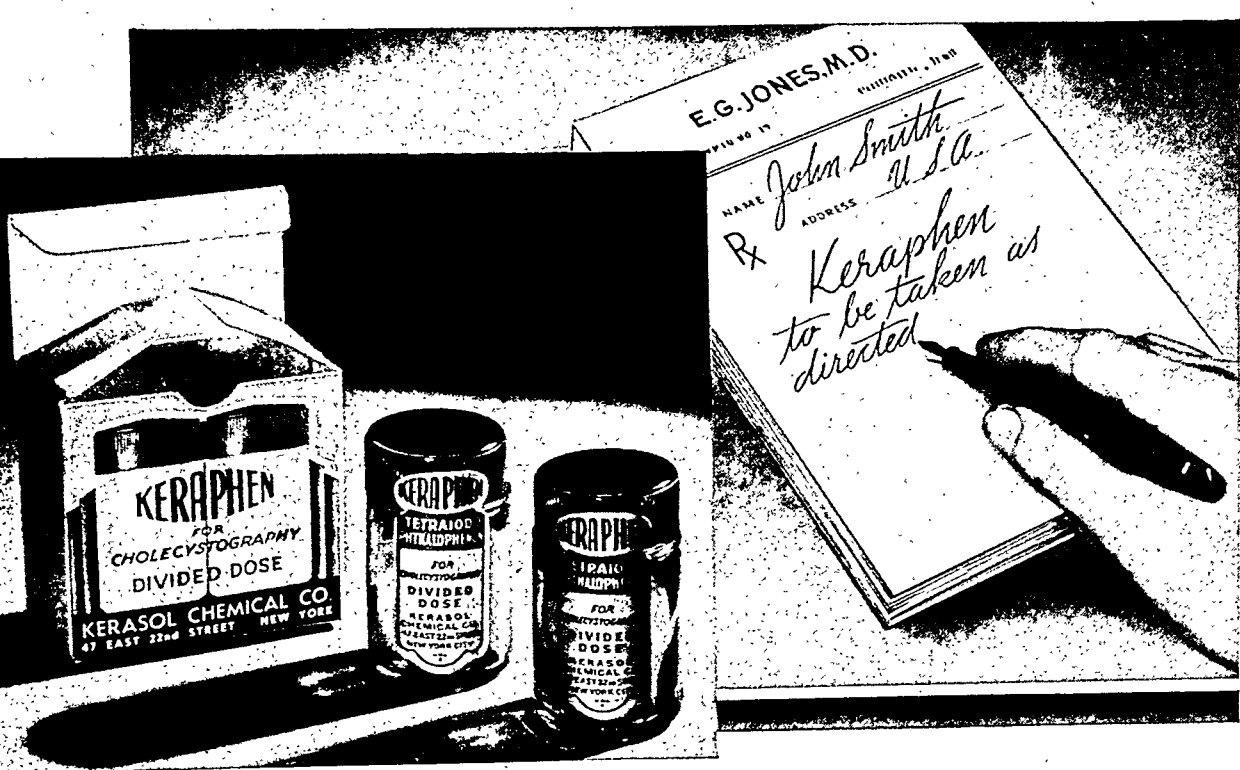
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A MONTHLY JOURNAL DEVOTED  
TO CLINICAL RADIOLOGY AND  
ALLIED SCIENCES



SEPTEMBER · 1938

VOLUME 31

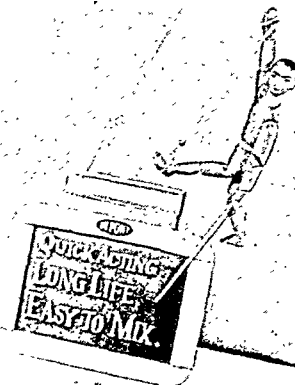
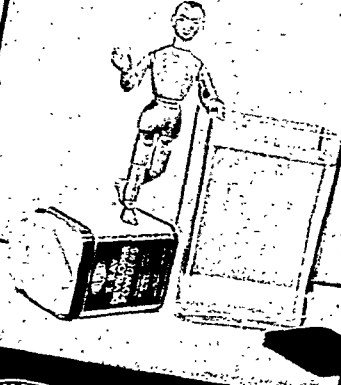
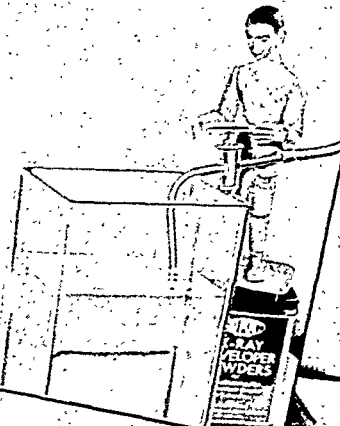
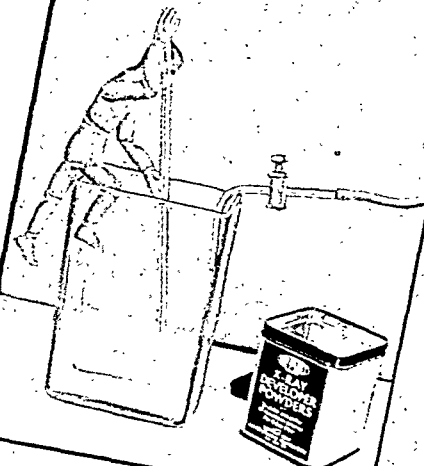
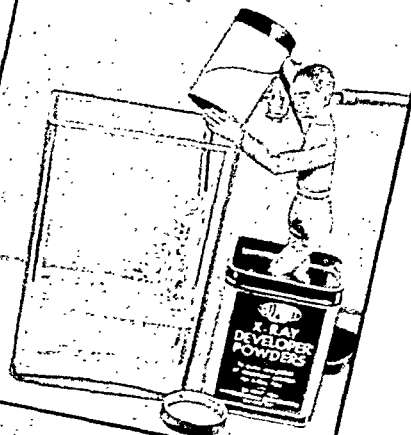
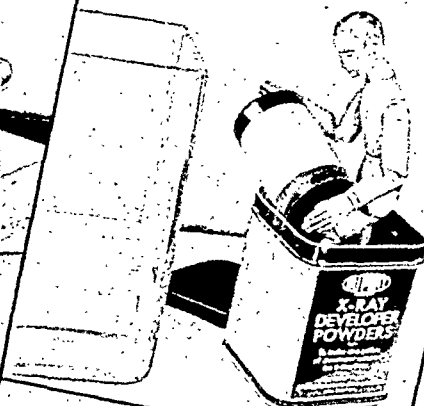
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JUST TRY SOME AND SEE.  
THE FIXER'S AS EASY,  
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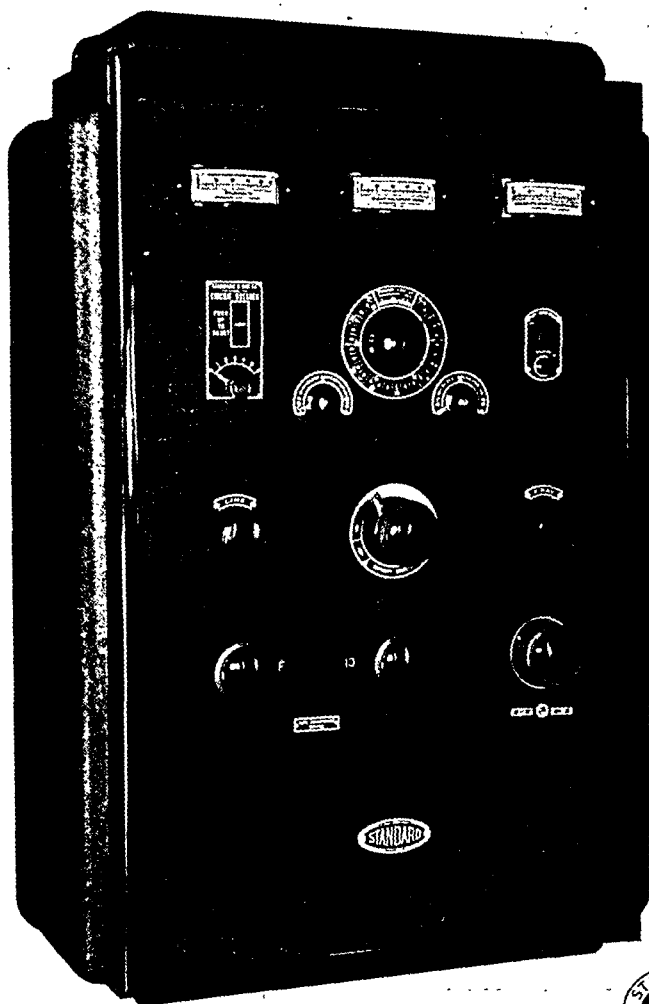
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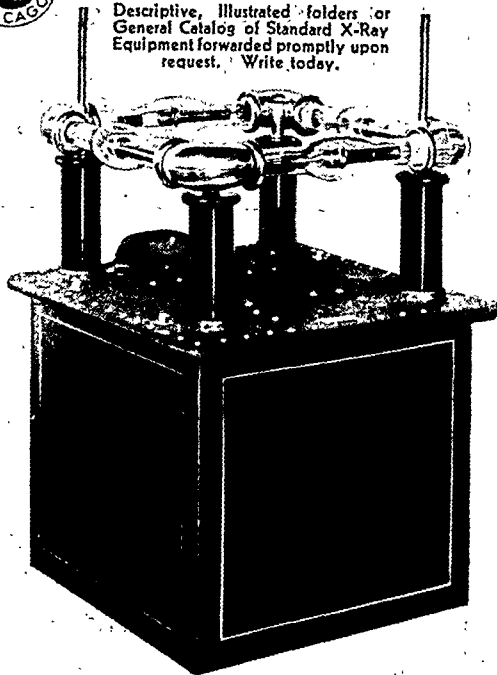
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## The Courses:

Sunday, November 27—Sessions: 10 a.m. to 1 p.m.; 2 to 5 p.m.

PHYSICS of RADIATION	RADIOLOGY of the CHEST	RADIOLOGY of the GASTRO-INTESTI- NAL TRACT	PATHOLOGY of TUMORS
AERO ROOM James L. Weatherwax, Physicist, Philadelphia General Hospital, Philadelphia, Pa. Edith H. Quimby, As- sociate Physicist, Me- morial Hospital, New York City	VENETIAN ROOM Dr. Walter W. Wasson, Attending Radiolo- gist, St. Anthony's and other hospitals, Den- ver, Colorado	CRYSTAL ROOM Dr. E. P. Pendergrass, Professor of Radiol- ogy, Univer. of Pa. Assisted by: Dr. Wm. Osler Abbott, Dr. J. Gershon-Cohen, Dr. I. S. Ravdin	ROOM 32 Dr. Wm. Carpenter MacCarty, Patholo- gist, Mayo Clinic

Monday, November 28—Sessions: 8 a.m. to 10 a.m.

PHYSICS of RADIATION (continued)	RADIOLOGY of BONE TUMORS	ROENTGEN ANALYSIS of FRACTURES	RADIOLOGY of SINUSES and MASTOIDS
AERO ROOM James L. Weatherwax Edith H. Quimby	VENETIAN ROOM Dr. J. T. Murphy, Chief of Roentgenol- ogy Dept., St. Vin- cent's Hosp., Toledo, Ohio. Assisted by Dr. Plinn F. Morse	CRYSTAL ROOM Dr. W. Edward Cham- berlain, Professor of Radiology, Temple Univer., Philadelphia, Pa.	ROOM 32 Dr. G. W. Grier, Pro- fessor of Roentgenol- ogy, University of Pittsburgh, Pittsburgh, Pa.

# Brief Description of Courses:

## PHYSICS of RADIATION

JAMES L. WEATHERWAX

Characteristics of roentgen radiation. Dosimetry, isodose curves, depth dose charts. Classification technics. Definition of Dosage. Recovery rates. Characteristics of radiation from radium or radon. Data concerning transmission by various filters, dosimetry, management of radia-

EDITH H. QUIMBY

tion. Biological effect of irradiation. Radiosensitivity, theories of radiation reaction, protective measures. Typical roentgen and radium therapy technics, factors to be considered. Records.

## RADIOLOGY of the CHEST

DR. WALTER W. WASSON

(1) Anatomy of the lungs with corrosive specimens demonstrating the bronchi and their air cells and the arteries and veins. (2) Anatomy of the lungs and thorax as portrayed by the roentgen film. (3) A discussion of the physiology of the lungs and mechanics of the thorax par-

ticularly as it pertains to roentgenology. (4) Diseases of the chest and particularly of the lungs with a discussion of their classification, portrayal and diagnosis. (5) Radiation therapy of the thorax and especially a discussion of its hazards.

## RADIOLOGY of the GASTRO-INTESTINAL TRACT

DR. E. P. PENDERGRASS

The course is planned to cover physiology of the G. I. tract, roentgenology of the G. I. tract and physiology of the gall bladder in both formal and open forum discussion. Tentatively, the presentation will consist of a discussion of the physiology of the G. I. tract for one and one-half hours by Dr. Abbott, following which one and one-half hours will be devoted to the roentgen examination of the

esophagus, stomach and small intestine by Dr. Pendergrass. Roentgenology of the colon will be covered by Dr. Gershon-Cohen at the fourth hour. Physiology of the gall bladder will be discussed by Dr. Ravdin during the fifth hour and the roentgenological aspect of the gall bladder by Dr. Pendergrass during the sixth hour.

## PATHOLOGY of TUMORS

DR. W. CARPENTER MacCARTY, Sr.,

A.M. (1) Brief historical sketch of the evolution of pathology, pathologists and radiologists, and the relation of each to the other and to clinical medicine. (2) Fundamentals underlying disease, the thing called inflammation and its relation to x-ray diagnosis and treatment. (3) Fundamentals of the evolution of neoplastic conditions, their physical and clinical characteristics and their relation to x-ray

diagnosis and radiological treatment. P.M.: (1) The language of disease. (2) Clinical and radiological classification of inflammatory and neoplastic disease. (3) Practical bio-pathological, physical and radiological classification of disease. (4) Difficulties of examining boards and those examined. (5) Suggestions for review. (There will be a ten minute recess between each subject.)

## RADIOLOGY of BONE TUMORS

DR. J. T. MURPHY

A course on radiology of bone tumors which is to be conducted as a clinical-pathological conference with Dr. Plinn F. Morse. The course is designed to emphasize

differential diagnosis and treatment. The field of bone tumors is to be tersely classified and illustrated examples of each class presented.

## ROENTGEN ANALYSIS of FRACTURES

DR. W. EDWARD CHAMBERLAIN

Roentgen analysis of fractures will be presented systematically; apparatus will be employed to illustrate certain features. Fluoroscopic methods will be demonstrated

and the many ingenious and helpful plans for the analysis and handling of fracture problems will be shown.

## RADIOLOGY of SINUSES and MASTOIDS

DR. GEORGE W. GRIER

Anatomy of sinuses and mastoids. Technical considerations in the production of radiographs of sinuses and mastoids; the author's plan of examination. Pathology of

diseases affecting sinuses and mastoids. Roentgen interpretation; correlation of roentgen findings and pathologies. Radiation therapy of sinuses and mastoids.

**T**HE Executive Committee has ruled that no charge shall be made for enrollment. Rooms available require the limitation to sixty in each course. Enrollment return cards will be mailed to all members one month before the date of the Annual Meeting. Members of the Radiological Society will be given preference and enrolled in the order in which the cards are received. Only sixty will be enrolled in each course.

## COMMITTEE ON PUBLICITY AND EDUCATION

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areas of adenomatous tissue which varied in size and outline. Many of these glandular areas had the basement membrane broken through and the large, irregularly shaped cells protruding through these openings were found to be widely scattered in the surrounding tissue. The pathological diagnosis was adenocarcinoma.

There was no post-operative hemorrhage or shock. The patient made an uneventful recovery and returned to her home at the end of three weeks. At the time of discharge she had full use of her right arm. Subsequent to the operation she was given Coley's fluid and two treatments of X-ray therapy.

For six years following her discharge from the hospital the patient enjoyed the full vigor of health. Over a period of two years she regularly reported to Dr. Cogswell for examination of the operative field. In June, 1929, about six years after the operation, she began to lose weight and strength and found that she could not get about the house and do her work without abnormal fatigue. During the next six

months this condition gradually grew worse and she went to her physician for examination at this time.

Dr. Cogswell reports that he found no signs of local recurrence and the pelvic organs were negative. The left breast and axilla were normal. There was a very general muscular flabbiness and the patient moved about slowly, complaining of pain in her spine and hips as well as in the arms. He referred her to Dr. J. S. Bragg for a complete X-ray examination of the osseous system. This X-ray survey revealed a marked involvement of the upper end of the radius, skull, humerus, upper end of the femur, upper end of the tibia, and a few spots in the upper end of the fibula.

The patient gradually lost weight, grew very weak, and in May, 1930, became bedridden. She progressively grew weaker and died in August of the same year. The

cause of death was general osseous metastasis involving the bones named.

## A USEFUL POSITION FOR EXAMINING THE FOOT

By HOWARD P. DOUB, M.D.,  
Department of Roentgenology, Henry Ford Hospital,  
DETROIT, MICHIGAN

For some time we have been using a position for examining the tarsal bones, which has certain advantages over the standard dorso-plantar and lateral positions. Inasmuch as this does not appear to be standardized, we have felt that a brief description of the position as we use it will be worth while.

In this position, the foot is inverted, with the outside elevated to a thirty-degree angle with the film holder (Fig. 1). The central ray is directed perpendicularly to the film and centered over the tarsal bones. We have found that if the angle which the foot makes with the film is increased more than thirty degrees, the external cuneiform tends to be thrown over the other cuneiform

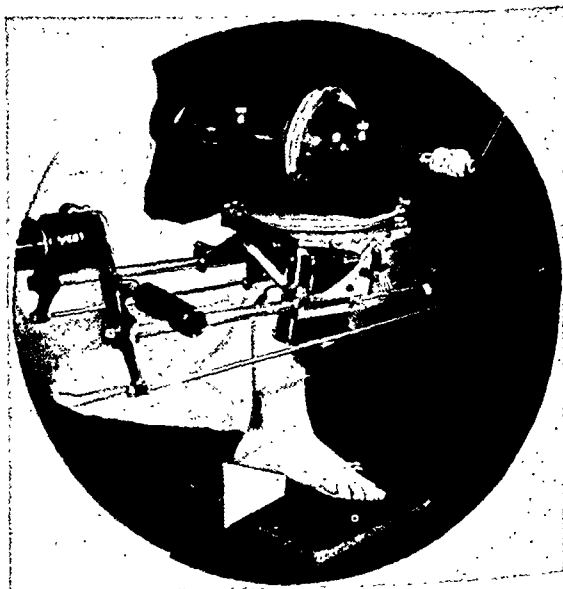


Fig. 1. Roentgenogram showing foot inverted, with the outside elevated to a thirty-degree angle with the film holder.

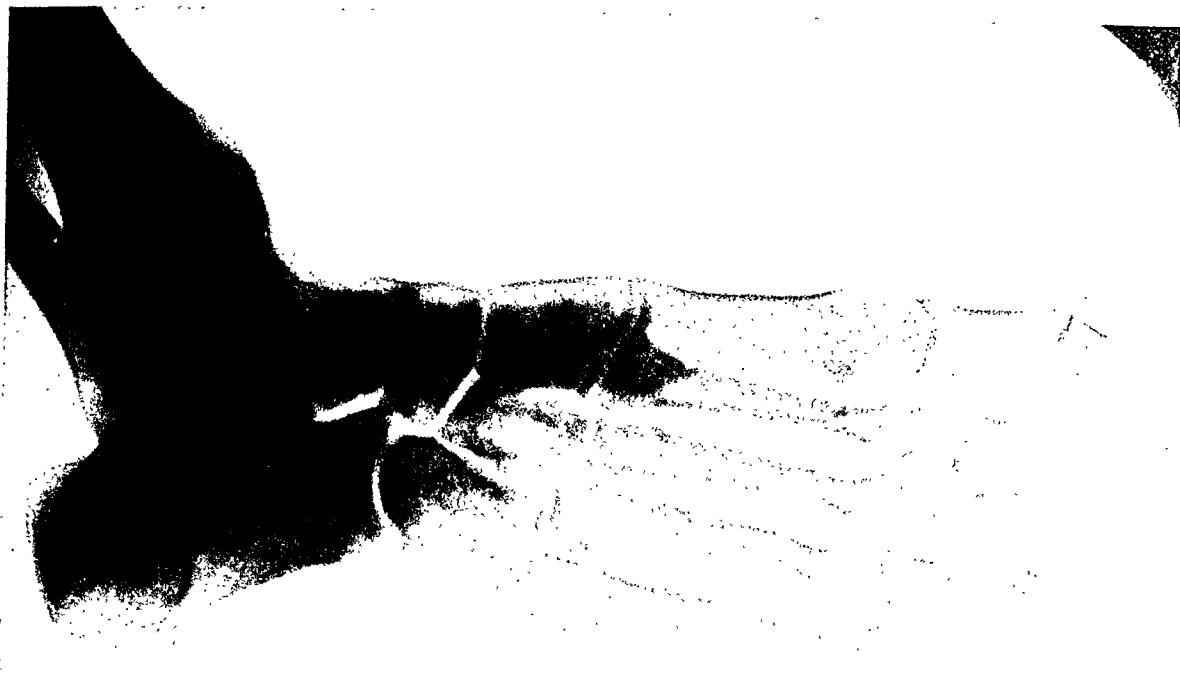


Fig. 2. Roentgenogram showing result from using position shown in Figure 1.

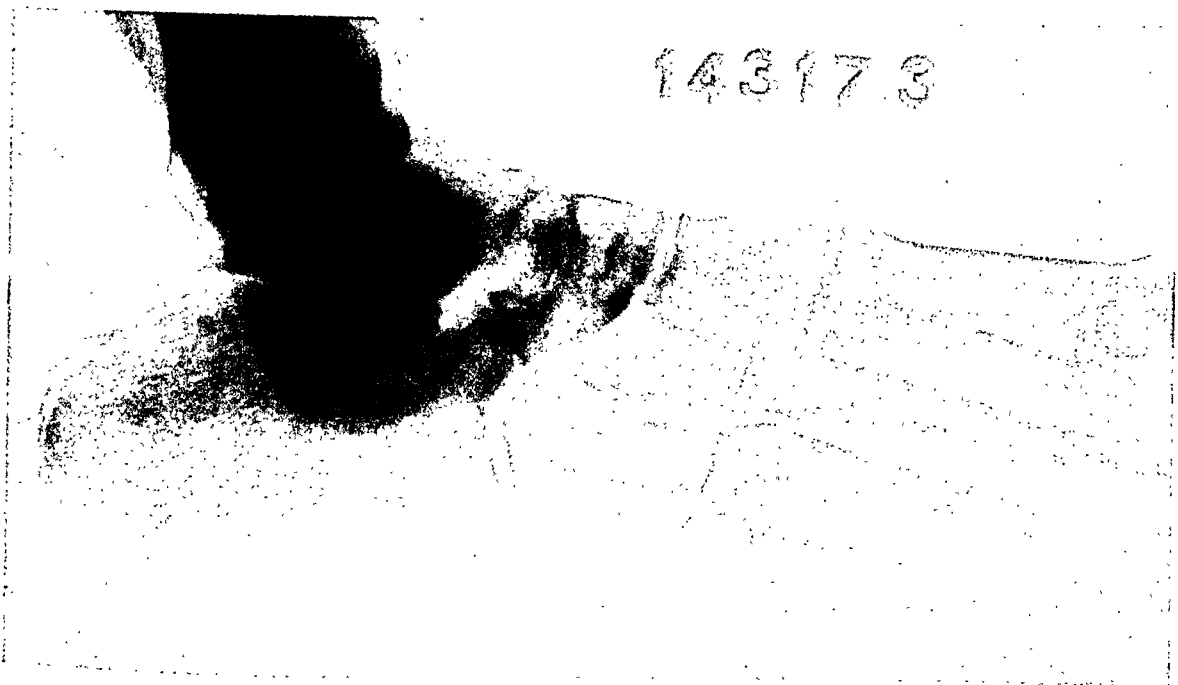


Fig. 3. Roentgenogram demonstrating coalition of the calcaneus and navicular, using this position.

bones so that it is not clearly shown. This angle is easily obtained by making a wooden angle board for insertion under the sole of the foot. The resultant film (Fig. 2) is quite different from that obtained by allowing the foot to remain flat and only tilting the tube.

This position is of particular value in the demonstration of coalition of the calcaneus and navicular, as described by Badgley<sup>1</sup> (Fig. 3). This should be looked for partic-

<sup>1</sup>Badgley, C. E.: Coalition of the Calcaneus and the Navicular. Arch. Surg., July, 1927, XV, 75.

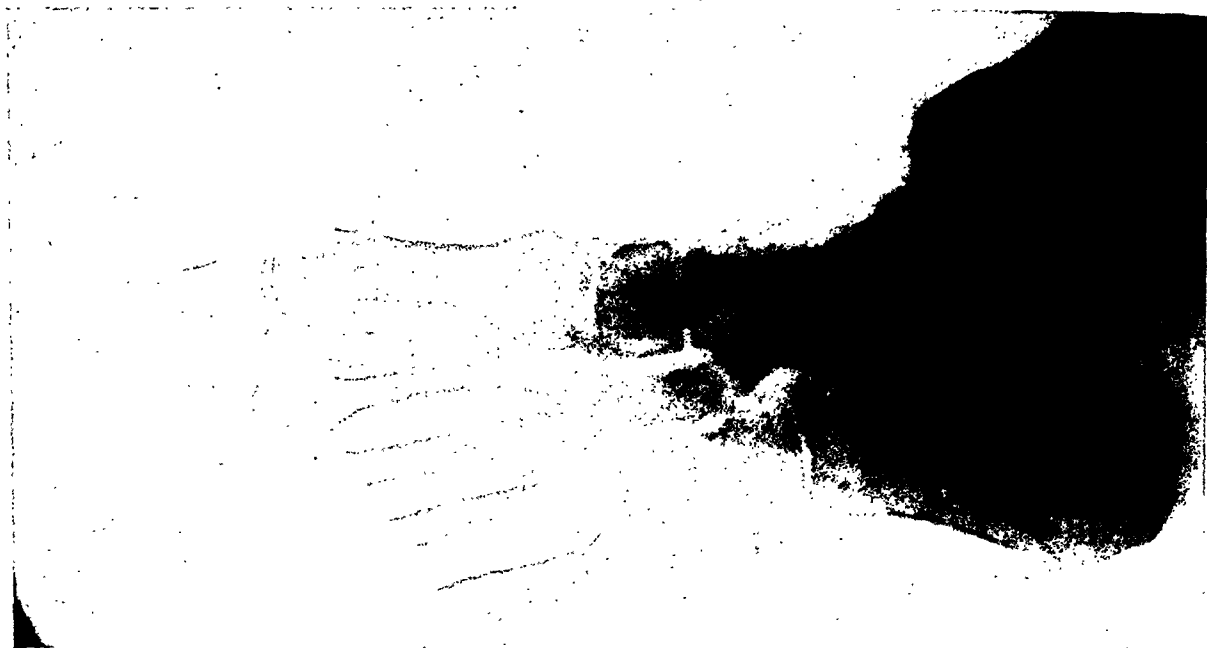


Fig. 4. Roentgenogram showing exact joint surfaces involved in infection of the tarsal and metatarso-tarsal articulations, using this position.

ularly in cases of rigid pes planus, with peroneal spasm.

A lateral view of the external cuneiform without the superimposition of other bones is accomplished quite effectively. The middle cuneiform is less easily demonstrated in the lateral or oblique positions, but can be shown in the dorso-plantar position. The cuboid and navicular are also seen to good advantage. The metatarsal bones and the phalanges are shown obliquely, which is of considerable value in cases of suspected fracture. The talus and calcaneus are not clearly demonstrated by this position.

In cases of infection of the tarsal and metatarso-tarsal articulations, this position has been found to be of great value in determining the exact joint surfaces involved in the process (Fig. 4).

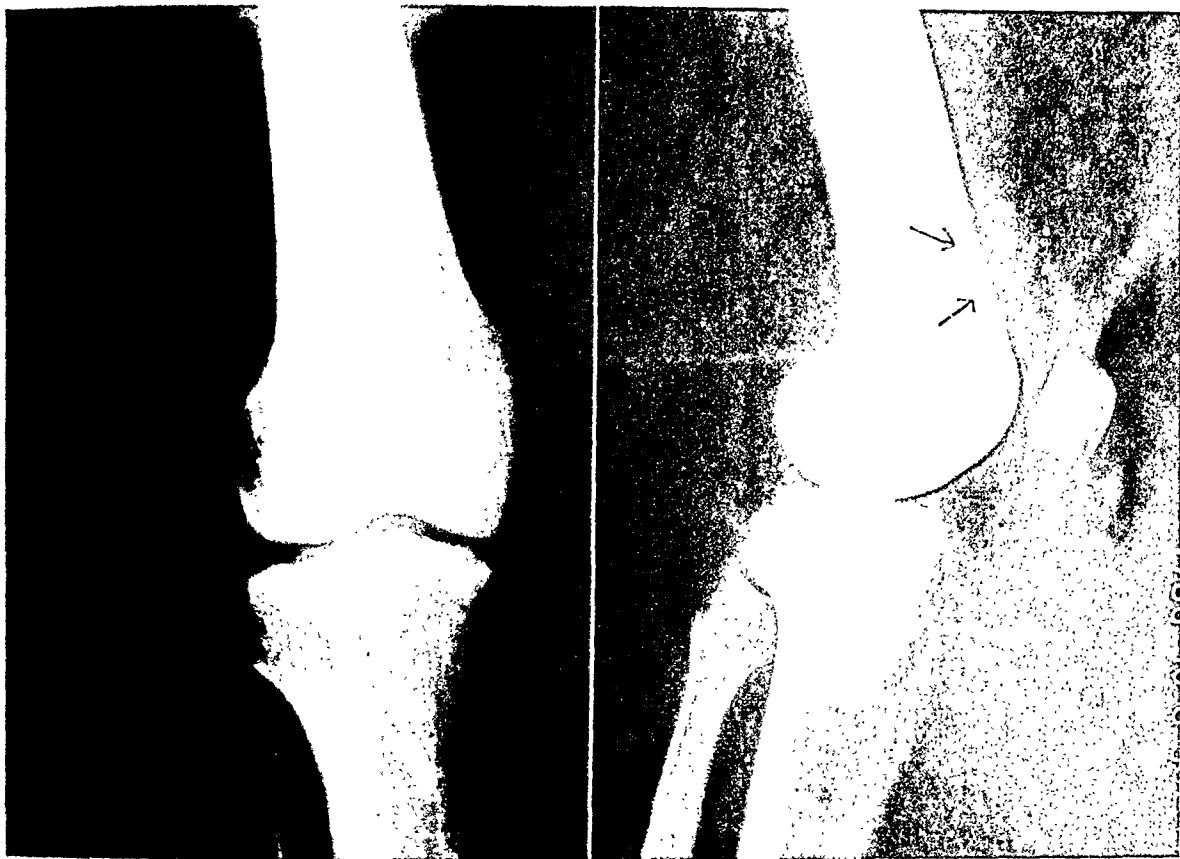
In conclusion, we believe this to be a good position for demonstrating most lesions of the fore-foot, particularly in cases in which we suspect coalition of the calcaneus and the navicular bones or pathology in the external cuneiform.

## REPORT OF TWO CASES OF OSTEOGENIC SARCOMA, POSSIBLY TRAUMATIC IN ORIGIN<sup>1</sup>

By BYRON H. JACKSON, M.D.  
SCRANTON, PENNSYLVANIA

Case 1. A. F., white, male, German, age 25, by occupation a mine laborer, was admitted to the Moses Taylor Hospital on October 4, 1930. He had been injured August 4, 1930, when he slipped on a piece of sheet iron in the mines, and fell across a railroad rail. He struck both femurs just above the knees, and received contusions over the inside of the right and outside of the left femur, two inches above the knee. He was treated by his physician for contusions for a short time, when the right leg, which was injured on the inside, was completely restored. The patient still complained of slight continual pain in the outside of the left leg, one inch above the knee. Nothing could be felt on examination. X-

<sup>1</sup>Reported before the November meeting of the Philadelphia Roentgen Ray Society, Philadelphia, Pa.



Figs. 1 and 2. Case 1. X-ray examination, made two months from the date of injury, disclosed a periosteal osteogenic sarcoma, and exhibited destruction of the cortex, invasion of the shaft, bony spicules within the soft tumor, and some elevation of the periosteum.

ray examination, made October 4, 1930, two months from the date of injury, disclosed a periosteal osteogenic sarcoma, and exhibited destruction of the cortex, invasion of the shaft, bony spicules within the soft tumor, and some elevation of the periosteum (Figs. 1 and 2). Amputation was refused, and X-radiation is being tried.

This case illustrates a definite trauma at the site of a malignant lesion in a patient who had previously exhibited no evidence of the disease.

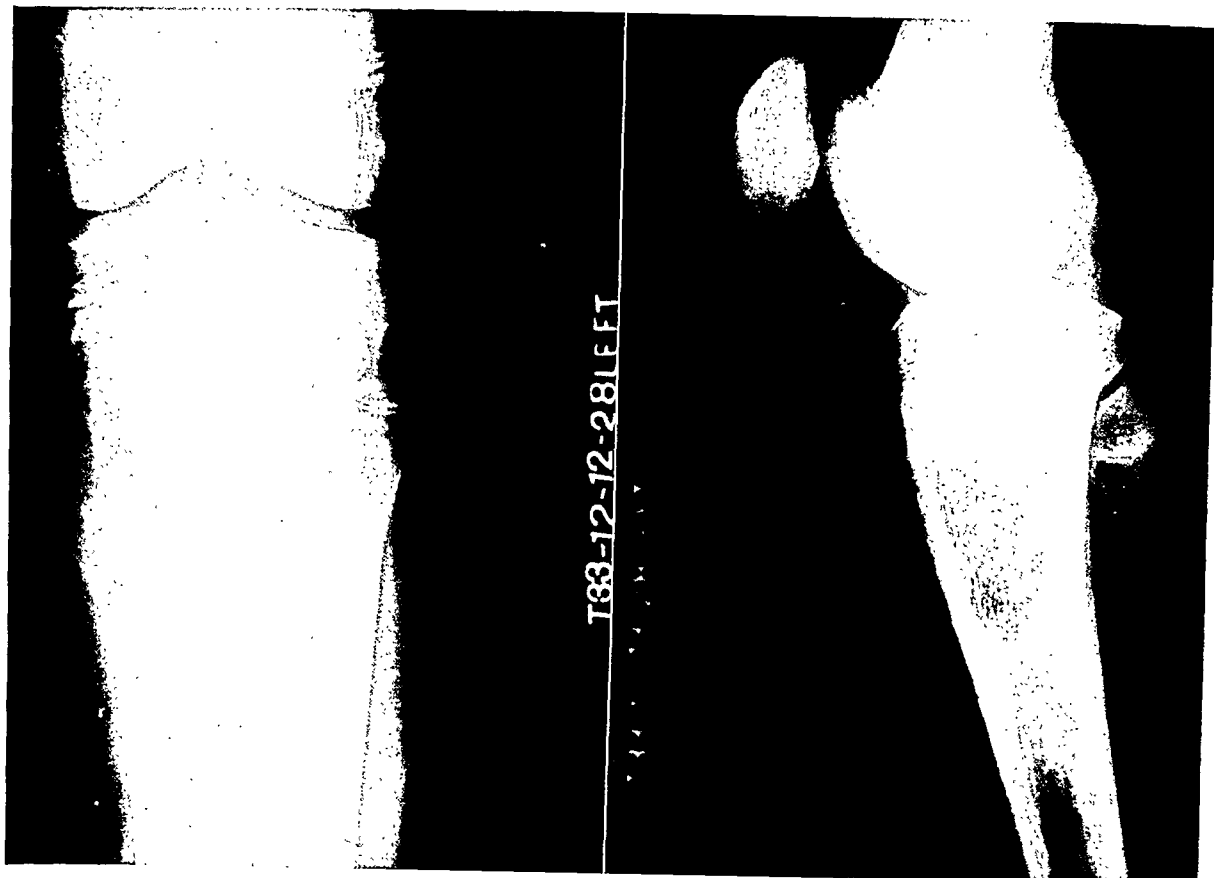
Case 2. H. L., aged 13, white, male, came to the Out-patient Department December 8, 1928, complaining of pain in the left knee following an injury three weeks before.

This school boy gave the following history: While playing at school three weeks previously, he had bumped his left leg

against a fire hydrant. He had not been to school since, but had not been confined to bed.

The left knee joint is apparently normal. Flexion is complete. The patella is freely movable. There are no signs of fluid in the knee, which is exactly the same in size as its fellow. The upper part of the left leg shows a diffuse fusiform swelling, more marked over the inner surface of the tibia. This swelling extends for about  $3\frac{1}{2}$  inches in the long diameter of the leg. The skin is slightly tense, not reddened. The swelling is definitely tender, slightly boggy; no fluctuation is felt, nor egg-shell crackle. The impression is that the bone itself is definitely injured and also that there is considerable swelling and edema in the soft parts. The temperature of the skin over the swelling is apparently higher than on





Figs. 3 and 4. Case 2. We have here a tumor involving the bone and soft tissues of the left tibia, upper, inner border. The tumor of the bone is nearly as wide as it is long. The cortex and shaft are destroyed. There is apparently no attempt at bone repair. There is some evidence of new bone within the soft tumor, with ossifying periostitis below the tumor.

the opposite side. The veins over the tumor are slightly more prominent. The ankle is normal. There is no pretibial edema below the tumor. There are definitely enlarged glands in the left groin and also in the left popliteal space. The glands in the right groin are also palpable, but not nearly so much so. Nothing can be felt in the abdomen.

*X-ray Examination.*—Films were taken December 8th, of the left tibia and fibula and knee, the right tibia and fibula (for comparison), and the lungs.

*X-ray Diagnosis.*—We have here a tumor involving the bone and soft tissues of the left tibia, upper, inner border. The tumor of the bone is nearly as wide as it is long. The cortex and shaft are destroyed. There is apparently no attempt at bone repair. There

is some evidence of new bone within the soft tumor, with ossifying periostitis below the tumor. A diagnosis of osteogenic sarcoma is made (Figs. 3 and 4). The lungs show no metastasis.

*Operation.*—At operation, December 17, 1928, under ether anesthesia, the swelling is found to be definitely larger than it was when the patient was examined four days before. The skin is not reddened nor tense, and not adherent to the tumor. There is, however, definite fluctuation. The tumor, especially over the inner surface of the head of the bone where it makes its most prominent salient, is very tender. The inguinal glands have not increased in size since December 13th. An incision about four inches long is made over the inner surface of the head of the tibia. There is some free blood

and edematous tissue present under the skin, which has given the impression of fluctuation. There is no pus. Practically the entire inner surface of the head of the tibia is broken down and can be wiped away with a sponge, without needing any bone-cutting instrument. This exposes a large cavity involving the entire head of the tibia. There is a moderate amount of apparently necrotic cancellous tissue, and clotted blood lying in this cavity, but no definite evidence of new growing bone tissue and no evidence of neoplasm. The walls of the cavity are ragged, irregular, trabeculated, having no smooth lining membrane. The impression, when this tissue is exposed, is that this is a bone cyst which has been broken by trauma and has very extensively degenerated since the trauma. Gross evidence is against pus or neoplasm. The cavity is curetted with the electric cauter and packed with iodoform gauze. Several irregular fragments of necrotic bone have been removed for microscopic examination, some of them to be sent to Dr. Joseph C. Bloodgood. An incision is then made over the most apparent gland in the groin and this removed. It is a flattened gland about  $\frac{1}{4}$  inch thick and  $1\frac{1}{4}$  inch in diameter. The cut surface presents a dull grayish appearance involving about one-half of the central portion. This gland is somewhat suggestive of neoplasm, but is not definite and does not give valuable

information until microscopic examination is made.

*Microscopic Examination by Dr. J. M. Wainwright.*—Gland, inflammatory. Osteogenic sarcoma of tibia.

*Microscopic Examination by Dr. J. C. Bloodgood.*—Osteogenic sarcoma of the upper end of the tibia shaft.

*Diagnosis.*—Bone tumor (periosteal sarcoma), osteogenic sarcoma—destructive type, giving an X-ray picture like bone cyst, upper end of the tibia. The following is an extract from a letter from Dr. Bloodgood: "This is a condition I have never seen before, a trauma changing the X-ray picture of a latent bone cyst. I trust you will report this case."

*Treatment.*—A radium pack was inserted within the cavity, which showed no tendency to granulate. The knee became fixed in a flexed position, with resultant atrophy of the leg and thigh. Later a mid-thigh amputation was done. The patient is now the picture of health. He has an artificial limb, has doubled his weight, and appears to be cured. Since there was no evidence of a bone lesion of any kind before the injury, it seems fair to presume that trauma may have been the causative factor. The contention that a bone cyst might have become malignant does not seem to be borne out by the fact that no lining membrane was found in this bone cavity.

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# EDITORIAL

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M. J. HUBENY, M.D. . . . . *Editor*  
BENJAMIN H. ORNDOFF, M.D. . . . *Associate Editor*

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## IRRADIATION AND PREGNANCY

The question, "Does maternal pelvic radium or roentgen irradiation injure the health or development of the next generation?" has been asked frequently ever since it was discovered that such treatment could modify ovarian function. If irradiation could produce temporary sterility, the ova to be cast off subsequently might have been permanently damaged. Fertilization of these ova might give rise to the birth of unhealthy or defective children. Furthermore, early experiments indicated that embryonic tissues were peculiarly sensitive to irradiation. This latter fact suggested that serious damage might result from the use of irradiation in the treatment of pelvic diseases in women who might be pregnant at the same time.

The necessity for an investigation in this field became increasingly evident as reports dealing with unhealthy or defective children, whose mothers had received pelvic irradiation, began to appear in the literature. Furthermore, with an increasingly widespread use of radium and roentgen therapy, more women in the childbearing age were being treated with substerilizing exposures. A definite knowledge of the possible relationship between maternal treatment and injury to the child's health could be gained only through a detailed process of research. Accordingly, this study was begun in the manner to be outlined.

As much clinical material as possible was collected. The literature was searched for all case reports bearing upon the subject. Unpublished observations were solicited by means of more than seventeen hundred letters sent to leading gynecologists and radiologists in this country and abroad. These data were then analyzed in order to discover the birth-frequency of unhealthy children. The information contained in these case reports was tabulated. Where important facts were missing, this point was noted. A personal letter was then sent to each observer of an undeveloped or unhealthy child. Information upon the missing points was requested, as well as the latest information regarding the health of the child. In addition to the case reports received from the above sources, some personal observations of the author were included.

The study was concerned with the health of children born after the use of therapeutic amounts of treatment. The influence of diagnostic exposures, either before or after conception, was not investigated. One observer described a child who had been exposed early in its embryonic life to some very short roentgen exposures, used for diagnostic purposes, the mother being under observation for a ureteral or bladder stone. The child was pictured as being a "cross between a Mongolian idiot and a cretin." Since this is the only record dealing with diagnostic amounts of exposure and the birth of a defective child, with the knowledge at hand there is every reason to believe that diagnostic irradiation during pregnancy is harmless.

The reports which dealt with therapeutic degrees of exposure are best viewed in two groups: those which concern children ir-

radiated *in utero* and those which describe children conceived after the maternal treatment had taken place.

A critical study of the records of the children conceived *after* maternal treatment led to the conclusion that such children were unharmed. Clinical evidence and most experimental evidence agree on this point.

Irradiation of the fetus *in utero*, however, gave a different picture. Nearly one-third of a group of 76 full-term fetuses, so exposed, exhibited a serious degree of developmental retardation. Most of these individuals were microcephalic, although other mental and physical defects were observed. The great frequency of underdevelopment and the uniformity of the lesions suggested most strongly that they had a common cause.

The reasons for the fetal irradiation were numerous. In some cases pregnancy had been considered no contra-indication to treatment. In others, the possible danger of the treatment had been overlooked, or the health of the future child had been entirely disregarded in the interest of the mother. However, in most instances the fetal irradiation had been purely accidental.

In fourteen cases pregnancy took place between treatments in a series of roentgen therapeutic exposures, the ensuing amenorrhea being attributed to the treatment. Here, at a very early age, the embryo was subjected to the full force of the remaining exposures, which were insufficient to produce death or abortion.

One convincing personal observation was as follows: A healthy mother gave birth to three healthy children. The fourth pregnancy was complicated by early uterine hemorrhage, for which a long series of roentgen exposures was given. It was believed at the time that the bleeding was due solely to a submucous myoma. In this case no curettage was carried out preliminary to the use of the irradiation. The child, now

five years of age, is microcephalic, with a mental age of little more than two years. Two years after the birth of this child a fifth child was born, who is normal in every respect.

These observations have led to the following conclusions: Pre-conception maternal pelvic therapeutic radium or roentgen irradiation is in no way harmful to the health or development of any subsequent child. This evidence seems to be clear-cut and without exception. During pregnancy diagnostic roentgen irradiation is a safe procedure. However, it would seem wise to delay its use as long as possible, and to use the minimum amount of exposure, especially in the very early months of pregnancy. On the other hand, therapeutic pelvic irradiation during pregnancy is extremely likely to injure the fetus. A preliminary curettage should precede the use of radium or roentgen treatments in women of the child-bearing age. By so doing, no unsuspected embryo would be irradiated unwittingly. Every precaution should be taken to make sure that no patient becomes pregnant between any two treatments in a series. Should a fetus become exposed to large amounts of irradiation, the pregnancy should be terminated before the period of viability, whenever possible. Should it become necessary to apply therapeutic pelvic irradiation early in pregnancy, the uterus should be emptied. If the pregnancy is advanced, an induction of premature labor should precede the treatment.

DOUGLAS P. MURPHY, M.D.  
*Philadelphia.*

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#### A NEW SCREEN

Our readers' attention is called to the announcement by The Patterson Screen Company of a new and faster intensifying screen, known as the Patterson Speed Combination. These screens are used in pairs.

one thin front screen and one thick back screen. By reducing the thickness of the front screen its absorption is reduced, thus permitting more of the X-radiation to act on the film direct and to excite the thick back screen. The manufacturer reports that this new Speed Combination retains all of the well-known qualities of the Patterson Cleanable intensifying screen, namely, freedom from grain, freedom from afterglow or lag, with good contrast, plus the added advantage of more speed.

### THE INDIANA ROENTGEN SOCIETY

The Indiana Roentgen Society held its fourth annual meeting in Indianapolis on February 21st. E. L. Jenkinson, M.D., of Chicago, was the speaker. The following officers were elected: *President-elect*, L. F. Fisher, M.D., of South Bend; *Vice-president*, H. C. Bernheimer, M.D., of Terre Haute; *Secretary-Treasurer*, J. N. Collins, M.D., of Indianapolis.

### PROGRAM OF THE THIRD CONGRESS OF THE PAN-AMERICAN MEDICAL ASSOCIATION AT THE CITY OF MEXICO

Sunday, July 26, 1931, 8:00 P. M.: Inaugural session, attended by the Honorable President of the Republic at the Bolivar Hall of the National Preparatory School.

Monday, July 27, 9:00 A. M.: Practical demonstrations in medicine and surgery in several hospitals and laboratories.

3:00 P. M.: Sessions of different Sections.

7:00 P. M.: Reception at Chapultepec Castle by the Honorable President of the Republic.

Tuesday, July 28, 9:00 A. M.: Practical demonstrations in medicine and surgery in several hospitals and laboratories.

1:00 P. M.: Lunch under the auspices of the Organization Committee at the National Preparatory School.

3:30 P. M.: Sessions of different Sections.

9:00 P. M.: Concert at the Hall of the National Preparatory School.

Wednesday, July 29, 9:00 A. M.: Visit to several branches of the Department of Public Health.

1:00 P. M.: Lunch under the auspices of the Department of Public Education.

3:30 P. M.: Sessions of different Sections.

8:00 P. M.: General Session at the National Academy of Medicine in honor of foreign delegates.

Thursday, July 30, 9:00 A. M.: Sessions of different Sections.

10:00 P. M.: Ball offered by the Department of Public Health.

Friday, July 31, 10:00 A. M.: Meeting of the Committee on Resolutions.

8:00 P. M.: Final general sessions.

A Scientific and Commercial Exposition will take place near the hall where the Sessions are to be held.

For the convenience of those attending the meeting special excursion rates have been arranged with the steamship lines and by railroads. From the Atlantic coast, *via* New York, by the Ward Line: Rate to Mexico City and return, first class, including railroad trip from Vera Cruz to Mexico City, \$150.00. From Havana, \$115.00.

Information may be obtained from any one of the following:

Dr. Francisco de P. Miranda, Executive Secretary of the Congress, Departamento de Salubridad, Mexico City.

Dr. Conrad Berens, Treasurer of the

Pan-American Medical Association, 35 East 70th St., New York City.

Dr. J. E. Lopez Silvero, Executive Secretary of the Association, Secretaria de Sanidad, Havana, Cuba.

## BOOK REVIEWS

**PRACTICAL RADIATION THERAPY.** By IRA I. KAPLAN, B.S., M.D., Director Division of Cancer, Department of Hospitals, New York City; Attending Radiation Therapist, Bellevue Hospital; Lecturer in Radiation Therapy, New York University and Bellevue Hospital Medical College; Director, New York City Cancer Institute, with a special chapter on Applied X-ray Physics by CARL B. BRAESTRUP, B.Sc., P.E., Radiation Physicist, Division of Cancer, Department of Hospitals, New York City; Physicist to Mt. Sinai Hospital, New York City. Illustrated; 354 pages. W. B. Saunders Company, Philadelphia, 1931. Price \$6.00.

This volume is a welcome addition to the sparse supply of available texts on radiotherapy, and is, in fact, the only book on the subject. For the teacher of radiation therapy this book will be a ready reference for "collateral reading." For the student it will be a welcome addition to lecture notes, as it makes available in brief yet more than elementary form the practical aspects of the specialty, omitting many theoretical as well as controversial problems. The non-mathematical or non-physical reader will be favorably impressed by the almost total lack of curves and tables. Throughout, the subject of radiotherapy is presented from the point of view of the clinician, treating patients in his every-day practice.

In X-ray therapy the author uses a cross-fire method with repeated divided doses; in radium therapy small doses, heavily filtered, are applied over a long period of time. Such

technics as are described in the text will serve as a basis for modifications according to one's experience.

**CANCER: ITS ORIGIN, ITS DEVELOPMENT AND ITS SELF-PERPETUATION: THE THERAPY OF OPERABLE AND INOPERABLE CANCER IN THE LIGHT OF A SYSTEMIC CONCEPTION OF MALIGNANCY. A RESEARCH.** By WILLY MEYER, M.D. Consulting Surgeon to the Lenox Hill and Post-graduate Hospitals. Pp. 427, with illustrations. Cloth. Price, \$7.50. Paul B. Hoeber, Inc., New York, 1931.

This book, based on the author's exhaustive study of the literature since 1917, deals with malignant tumors as an ordinary lawful reaction of tissue to certain systemic and local morbid conditions of the human body; it denies the autonomy of cancer; it asserts the probable unity in character of all types of newgrowths; it recognizes chronic irritation coupled with a predisposition to cancer as the probable cause of all types of tumors, and it holds that persons with a degree of alkalinity of their body fluids higher than normal are predisposed to cancer, those with an acidosis probably being immune to it.

The author states that both the stage of mere presence of cancer susceptibility before there is any local irritation, and the stage of mere presence of local chronic irritation before the patient has, by trauma, acquired a susceptibility, are amenable to prophylaxis by suitable medical means. The stage of active tumor should be treated by a simultaneous attack on both chronic irritations by a correctly selected combination of surgery and medication.

Such a thesis as this, which presents cancer from a quite different angle, deserves serious study and consideration.

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CHEMICAL<sup>1</sup>

An X-ray Investigation of the Crystals of Azobenzene. Mata Prasad. *Phil. Mag.* [7], 1930, X, 306.

Crystals obtained by slow evaporation from alcohol belong to the monoclinic prismatic class with the lattice constants  $a = 12.65$  A.U.,  $b = 6.06$ ,  $c = 15.60$ ,  $\beta = 114^\circ 24'$ , and with the axial ratios  $a:b:c = 2.087:1:2.574$ . The space group is  $C_{2h}^2$  and requires 4 molecules per unit cell. A remarkable feature is a nearly complete symmetry about the  $(20\bar{1})$  plane, both in respect to geometrical relations and to intensities of reflection by corresponding planes.

## CHEMICAL ABSTRACTS.

The Influence of Chemical State on Critical X-ray Absorption Frequencies. H. R. Robinson and C. L. Young. *Phil. Mag.* [7], 1930, X, 71 (cf. *Chem. Abs.*, XVIII, 623).

By an improved satisfactory technic the  $K$  levels of Cr in metal and in hydroxide were measured. For Cr metal  $\tau/R = 440.99$ , agreeing with Lindh's value.  $\Delta\tau/R$  for Cr  $(OH)_2$  and Cr  $K$  levels was found to be  $0.5 \pm 0.15$  Rydberg unit, which is only one-half of Lindh's value. The discrepancy is not due to a dehydration effect.

## CHEMICAL ABSTRACTS.

Quantitative Spectroscopic Analysis with Secondary X-rays. G. v. Hevesy, J. Böhm, and A. Faessler. *Ztschr. f. Physik*, 1930, LXIII, 74.

X-rays, coming from the suitably excited substance, whose composition has to be determined, are analyzed spectroscopically. From the intensities of the emission lines (*e.g.*,  $K_\alpha$ ) compared with those from a suitable element added to the sample in known quantity, the concentration of the former may be obtained. It has been found that it is necessary to use secondary X-rays to excite the compound to be analyzed, because the ordinary electron impact alters the composition by selective evaporation. The X-ray tube consists of a glowing cathode surrounded by a cylinder with a

little carrier which contains the compound to be analyzed and is placed at a short distance from the anticathode supplying the primary X-rays. The intensity of current through the X-ray tube may be considerable (20 ma.), as the ray coming from the cathode must not be centered. A maximum intensity is obtained, when the primary  $K_\alpha$  radiation of the anticathode is about 200 X.U. harder than the  $K$  absorption edge of the secondary radiator, the continuous spectrum contributing but little to the total radiation. The yield of secondary radiation increases considerably for a given input when the tension is raised; therefore it is advisable to run the X-ray tube with low intensity of current. The intensity of lines, whose potential of excitation does not differ more than 250 X.U., is independent of the tension applied to the tube. The time of exposure was generally 2 to 3 hours, the precision of estimation 0.01, if the element was present in a concentration of 1 per cent. The various sources of error are discussed and a list of elements of reference is given.

## CHEMICAL ABSTRACTS.

The Crystalline Structure of Rubidium Azide. Linus Pauling. *Ztschr. f. phys. Chem.*, 1930, Abt. B, VIII, 326.

Polemical. The structure proposed by Günther and co-workers (*Chem. Abs.*, XXIV, 2930) for Rb azide is inconsistent with the known values of atom radii. A structure similar to that of K azide is to be preferred. (*Reply*: P. Günther and P. Rosbaud. *Ibid*, 329.)

## CHEMICAL ABSTRACTS.

X-ray Intensity Measurements with Deformed Crystals. J. Hengstenberg and H. Mark. *Ztschr. f. Physik*, 1930, LXI, 435 (cf. *Chem. Abs.*, XXIV, 3947).

The application of X-ray intensity measurements to the study of small changes in structure due to mechanical, chemical, thermal, and electrical influences is discussed. Reflections from the cubic faces of sylvine during distortion were obtained with an ionization spectrometer. The increase in (200) and (400) reflections with distortion is due to an increase

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in mosaic-like structure, while diminution in (600), (800); and (1000) reflections is due to deformation of the grating elements. Measurements of line width show disturbances at the slip planes to be local; a 3.8 per cent compression disturbs 2.25 per cent of the atoms with a maximum amplitude  $\frac{1}{8}$  of the atomic spacing.

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CHEMICAL ABSTRACTS.

**Intensity Measurements of Diffuse X-rays Reflected from Distorted Sylvine.** R. Brill. *Ztschr. f. Physik*, 1930, LXI, 454.

An apparatus for X-ray measurements, using the Geiger counter method, is described. Measurements show an increase in intensity of diffuse radiation, with deformation of the crystal.

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CHEMICAL ABSTRACTS.

**New Investigation on the Blue-gray Bright Spot Radiation of the Lilienfeld-Röntgen Tubes.** Franz Rother and Willi M. Cohn. *Physik. Ztschr.*, 1930, XXXI, 687.

Visible radiation from Lilienfeld tubes has been studied from 520 to 225 m $\mu$ . An intensity maximum occurs at 450 m $\mu$ . The radiation could not be resolved into lines or bands and probably extends far into the ultra-violet. The limits and intensity distribution in the continuous spectrum are unchanged with different anticathode materials.

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CHEMICAL ABSTRACTS.

**Difference in the Intensities of X-ray Reflection from the Two Sides of the III Plane of Zinc Blende.** D. Coster, K. S. Knol, and J. A. Prins. *Ztschr. f. Physik*, 1930, LXIII, 345.

The authors investigate the phase jumps of X-rays of wave length immediately on either side of the *K* absorption edge of Zn in ZnS. The large ratio of the absorption coefficient for the two wave lengths (1:20) occasions a phase displacement of the order of 10°. The observation is rendered possible by the fact that the Zn (111) plane divides the distance between two neighboring S (111) planes in the ratio of 1 to 3. Phase differences of 80° and 110° for first order and 280° and 260° for

third order are obtained on opposite sides of the crystal planes between Zn and S components of the diffraction spectra. The resultant difference in intensity is observed experimentally by the use of the Au *L* and W *L* lines.

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CHEMICAL ABSTRACTS.

**New X-ray Spectrograph with Absolute Zero Determination without a Divided Circle and the Zero Method of Cornu.** H. Seemann. *Ztschr. f. Physik*, 1930, LXI, 416.

A new X-ray spectrograph is described. The method at present almost universally used for the determination of the zero point with the Bragg spectrograph is that due to Cornu (1880). An arrangement is shown for the determination of the zero point by this method, using a pin-hole camera, and the new spectrograph employs a pin-hole camera, but has a new method for determining the zero point. The crystal is mounted on a table on a rod which can rotate through 180° about a vertical axis with accuracy, obviating the use of a divided circle. The rotation can take place in either direction, and the table is accurately fixed in position by contact screws. The principle of the method and the sources of error are discussed.

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CHEMICAL ABSTRACTS.

**The Determination of the Inner Structure of Liquids by X-ray Means.** P. Debye and H. Menke. *Physik. Ztschr.*, 1930, XXXI, 797.

The general method adopted is to start with the experimental results and work toward the structure rather than to assume a structure and derive the theoretical result. Because it is monatomic, liquid Hg was used for the experimental work, and, to simplify the absorption correction, the method of surface reflection was used. The intensity of reflection from a volume of *N* atoms, if there be no interference between scattered rays, is given by:

$$I = \frac{1 + \cos^2 \theta}{2} N \psi^2,$$

where  $\psi^2$  is a function of  $\theta$ , the angle between the primary and secondary beams, which characterizes the scattering from single atoms (*i.e.*, the so-called atom-factor). The observed results do not agree

with this expression, but may be expressed by  $I = \frac{1 + \cos^2 \theta}{2} N \psi^2 E(s)$ , where  $s = 2 \sin \theta/2$  and  $E(s)$  is a purely experimentally determined function of  $s$ . The experimental  $E(s)$  vs.  $s$  curve has the form of a damped vibration curve above and below the value  $E(s) = 1$ , which is approached at high values of  $s$ . If  $W$  be taken as the probability that the second of two atoms will lie in a volume  $dV$ , distant  $r$  from the first atom, it can be shown that:  $s [1 - E(s)] = \frac{2\lambda^2}{d^3} \int_0^s p [1 - W(p)] \sin 2\pi \text{spdp}$ . Here the variable is not  $r$  but  $p = \frac{r}{\lambda}$  where  $\lambda$  is the wave length.  $d$  is defined by  $Nd^3 = V$ , where  $V$  is the whole volume under consideration.  $W$  is not known as a function of  $p$ , but, instead,  $E(s)$  is known as a function of  $s$ . By the methods of Fourier, there results  $p [1 - W(p)] = \frac{2d^3}{\lambda^3} \int_0^s s [1 - E(s)] \sin \pi p s ds$ . The integration may be performed by using the experimental relation between  $E(s)$  and  $s$ . The problem worked out for Hg shows that certain distances, i.e., 3, 5.6, and 8.1 Å.U., are the most probable distances between atoms. Thus a quasi-crystal structure is present even in a liquid.

## CHEMICAL ABSTRACTS.

**An X-ray Analysis of the Copper-manganese Alloys.** Elis Persson. *Ztschr. f. phys. Chem.*, 1930, Abt. B, IX, 25.

An X-ray crystallographic analysis of the Cu-Mn system is reported and the possibility discussed of a continuous transition of the Cu-phase into the  $\gamma$ -Mn-phase, with increasing Mn content. It is shown that the  $\gamma$ -Mn-phase, ordinarily stable at high temperatures only, becomes stable at ordinary temperatures when alloyed with small quantities of Cu and chilled. The boundary of this phase occurs with concentrations of 83 atomic per cent Mn. The lattice parameter of the Cu-phase increases with increasing Mn content, from 3.008 to 3.74 Å.U. with 50 per cent Mn, then remains constant to the phase boundary. The atomic

volume in both simply built phases appears to change continuously over the entire system. Alloys consisting of these phases are formed with considerable expansion.

## CHEMICAL ABSTRACTS.

**Investigation of Gold-copper Alloys by Means of X-rays.** K. Ohshima and G. Sachs. *Ztschr. f. Physik*, 1930, LXIII, 210.

Above 400° an alloy of Au + Cu crystallizes in the cubic face-centered system (lattice construction  $a = 3.866$  Å.U.). Below 400° a tetragonal lattice of AuCu ( $a = 3.95$ ,  $c = 3.68$  Å.U.) and a cubic face-centered lattice of AuCu<sub>3</sub> occurs. The influence of heating and cooling on the structure is studied by means of rotation and Debye-Scherrer diagrams.

## CHEMICAL ABSTRACTS.

**Calculation of the X-ray Terms of the Lighter Elements and the Rare Gases from the Optical Potential of Ionization.** Werner Braunbek. *Ztschr. f. Physik*, 1930, LXIII, 154; 718.

The potentials of excitation of  $K_\alpha$  of Li, Be, B, and C are obtained from the ionization potentials of  $\text{Li}^+$ ,  $\text{Be}^{++}$ ,  $\text{B}^{+++}$ ,  $\text{C}^{++++}$ , by taking account of the screening effect of the outer electrons on an electrostatic basis (under very simplifying assumptions). For the heavier rare gases Ne, Ar, Kr, and Xe the effect of the outer electrons is obtained from the screening number of Sommerfeld's theory of the relativistic doublets.

## CHEMICAL ABSTRACTS.

**The Lattice Constants of the Elements.** William Hume-Rothery. *Phil. Mag.* [7], 1930, X, 217.

An examination of the measured lattice constants reveals a law of sub-groups which states that in any sub-group of the periodic table, provided that the co-ordination number remains constant, the interatomic distance  $d$  is given by the relation  $d/n = (1/aZ)^x$ , where  $n$  is the principal quantum number of the outermost shell of electrons remaining attached to the ions,  $Z$  is the atomic number,  $x$

is a constant which is the same for groups with the same number of electrons in the outermost shell, and  $a$  is a second constant which in some groups may be connected with the valency. The table gives the values of  $a$  and  $x$ .

Group	Elements	$a$	$x$
IA	Li, Na, K, Rb, Cs	0.0157	0.344
IIA	Be, Mg, Ca, Sr, Ba	0.02265	0.35
IVA	C, Si, Ti, Zr, Hf	0.0465	0.345
VA	V, Ta	0.0628	0.368
VIA	Cr, Mo, W	0.0675	0.376
VIIIA	Fe, Ru, Os	0.05998	0.404
VIIIB	Co, Rh, Ir	0.05689	0.418
VIIC	Ni, Pd, Pt	0.05808	0.39
IB	Cu, Ag, Au	0.05105	0.393
IVB	Ge, Sn	0.0588	0.33
VB	As, Sb, Bi	0.04753	0.323
VIB	Se, Te	0.0944	0.21
O	Kr, Xe	0.02735	0.348

In some cases the error in the calculated value is 1 per cent but usually the calculated value is in much closer agreement with the determined. The value of  $x$  reaches a maximum in Group VIII B. The value of  $a$  is not strictly proportional to the valency. The change in co-ordination number does not cause the same percentage change in the different groups; in Group IV its effect is comparatively slight. In the first short period the interatomic distance  $d$  is inversely proportional to the atomic number  $Z$ ; in the second period,  $d$  is inversely proportional to  $Z^2$ ; in the third group, to  $Z^3$ ; in the fourth group, almost to  $Z^5$ . The interatomic distance for Al does not fit into the scheme, indicating that it is probably not fully ionized in the metallic crystal.

#### CHEMICAL ABSTRACTS.

**The Total Reflection of X-rays.** Erich Nähring. *Physik. Ztschr.*, 1930, XXXI, 799.

The formula given below is derived:

$R = \frac{1 - aq + a^2/2}{1 + aq + a^2/2}$ , where  $R$  is the ratio of the reflected to the incident intensity,

$$a^2/2 = q^2 - 1 + \sqrt{(q^2 - 1)^2 + k^2}, \quad q = \frac{\theta}{\theta_0},$$

$$= \frac{\theta}{\sqrt{2\epsilon}}, \quad \theta \text{ being the angle of incidence and } \epsilon$$

the deviation of the index of refraction from 1,  $k = x/\delta$ ,  $x$  being given by  $n = (1 - \delta) - ix$ .

The formula has been verified with experi-

ments in which X-rays between  $\lambda = 1.242$  Å.U. and  $\lambda = 2.358$  Å.U. were reflected from Ag. The verification was made indirectly,  $\delta$  being calculated by the Drude-Lorenz formula. It is pointed out that the formula may be used to determine the index of refraction for long X-ray wave lengths.

#### CHEMICAL ABSTRACTS.

**Contribution to the Knowledge of the K X-ray Absorption Spectrum of Nickel, Copper, and Zinc.** Axel E. Lindh. *Ztschr. f. Physik*, 1930, LXIII, 106.

The wave lengths of the absorption edges of Ni, Cu, and Zn depend on the chemical state of the elements; the frequency shift amounts for  $\text{ZnSO}_4$  to 6 v.; for  $\text{ZnS}$  to 3 v.; for  $\text{ZnK}_2(\text{SO}_4)$  to 6 v. For Ni and Cu the absorption edge is double and possesses fine structure. Apparatus: Siegbahn vacuum spectrograph, calcspar crystal.

#### CHEMICAL ABSTRACTS.

**Determination of the Degree of Polymerization of Some Modifications of Polyoxymethylene by Means of X-ray Methods.** Emil Ott. *Ztschr. f. phys. Chem.*, 1930, Abt. B, IX, 378 (cf. *Chem. Abs.*, XXIV, 3147).

The method is the same as that used in the previous paper. A high accuracy is claimed. Paraformaldehyde consists of 32 formaldehyde groups,  $\gamma$ -polyoxymethylene of 60 groups, and  $\delta$ -polyoxymethylene of 24. The length of a formaldehyde group is 1.88 to 1.89 Å.U. It is shown that in highly polymerized substances molecules of equal length form the crystals.

#### CHEMICAL ABSTRACTS.

**A Classification System of the Silicates Based upon Crystal Structure.** St. v. Náray-Szabó. *Ztschr. f. phys. Chem.*, 1930, Abt. B, IX, 356.

A new classification system of the silicates based upon their crystal structure is developed. It is based upon the various arrangements of the Si and O atoms. The principal

groups are: (1) ( $\text{SiO}_4$ ) group, orthosilicates; (2) independent groups, with a greater content of Si (e.g.,  $\text{Si}_2\text{O}_7$ ); (3)  $\text{SiO}$  chains; (4)  $\text{SiO}$  planes, and (5) 3-dimensional  $\text{SiO}$  network lattices. A large number of the silicates are entered into this system in a set of tables. Some of the properties of the silicates are explained on the basis of their structure.

## CHEMICAL ABSTRACTS.

**The Reflection of X-rays on Absorbing Ideal Crystals.** J. A. Prins. *Ztschr. f. Physik*, 1930, LXIII, 477.

The dynamic theory of X-ray reflection (Ewald-Darwin) is extended to include absorption effects. It results that the intensity distribution inside a spectral line must be unsymmetrical with respect to the angle of regular Bragg reflection (corrected for the refractive index). The total intensity is also perceptibly influenced by absorption.

## CHEMICAL ABSTRACTS.

**X-ray Determination of the Solubility of Copper in Silver.** N. V. Ageev and G. Sachs. *Ztschr. f. Physik*, 1930, LXIII, 293.

The variations of the lattice dimensions of Ag containing Cu (less than necessary for the formation of mixed crystals) is used as a measure of the Cu content. To obtain reliable results, the surface of the material has to be perfect; this is best obtained by melting the alloy in a vacuum furnace. The solubilities of Cu in Ag at various temperatures are given.

## CHEMICAL ABSTRACTS.

**The Structure of Chromium Trichloride.** Nora Wooster. *Ztschr. f. Krist.*, 1930, LXXIV, 363 (in English).

$\text{CrCl}_3$  was obtained by sublimation in dry Cl at about  $1000^\circ$  in the form of extremely thin hexagonal plates, violet in color. It is optically negative and the Becke line (seen with great difficulty) suggests an index between 1.63 and 1.64. Specific gravity was de-

termined as 2.87, which is higher than the usual value (2.77). A combination of X-ray methods gave the following results: space group  $D_{3d}^3$ , or  $D_{3d}^5$ , unit cell contains 6 molecules;  $a = 6.02$  Å.U. and  $c = 17.3$  Å.U. These data differ from those of Natta (*Chem. Abs.*, XXI, 2406). The Cl atoms have a cubic close-packed arrangement, and each Cr atom is surrounded by 6 Cl.

## CHEMICAL ABSTRACTS.

**The Absorption of X-rays in Gases and Vapors: I.—Gases.** J. A. Crowther and L. H. H. Orton. *Phil. Mag.* [7], 1930, X, 329.

New measurements using Cu  $K$  radiation gave the following results:

	$u$	$I_v$	$I_m$
Air .....	9.46	1.000	1.000
$\text{N}_2$ .....	7.43	0.743	0.766
$\text{O}_2$ .....	11.14	1.438	1.301
$\text{CO}_2$ .....	9.30	1.530	1.006
$\text{CH}_2:\text{CH}_2$ .....	4.32	0.508	0.524
$\text{H}_2\text{S}$ .....	82.7	14.96	12.58

$u$  = mass absorption coefficient.

$I_v$  = relative ionization for equal volumes.

$I_m$  = relative ionization for equal masses.

The fraction of absorbed X-ray energy utilized in producing ionization is approximately constant for the majority of gases except  $\text{N}_2$ , for which it is 15 per cent greater.

## CHEMICAL ABSTRACTS.

**The Action of X and Gamma Radiation upon Aqueous Solutions of Iodine and Potassium Iodide.** G. Harker. *Med. Jour. Australia*, Dec. 20, 1930, II, 817.

It is shown that Bordier's statement that iodine in aqueous solution disappears under the influence of X-rays is erroneous, his effect being due to the interaction between the iodine solution and the paraffin which he used to coat the cardboard box of his experiments. The radiation employed was derived from a Coolidge water-cooled therapy tube energized at 40 K.V. constant potential, and 2.5 ma. at 12 cm. target-object distance for



a period of one hour. No filtration is mentioned. Two tubes of iodine solution of concentration such that 3 c.c. reacted exactly with 0.20 c.c. N/500 sodium thiosulphate solution were exposed. One tube was shielded by lead (thickness not stated), the other with a sheet of black paper. At the end of one hour, each tube required 0.16 c.c. of N/500 sodium thiosulphate solution for exact reaction. That is to say that there was no difference between the irradiated and non-irradiated solutions. Starch iodine solution was also unaffected by X-rays in the above dosage. It is not made clear that thermal effects were entirely eliminated by the method of using the screened control—and temperature effects have been a fallacy in many biological experiments with X-rays.

The author mentions, however, that using 65 K.V. and 2.5 ma., the solution, "unprotected by lead, was exposed to a higher temperature, with a small increase in the loss of iodine caused by reaction with water." He does not show that the effects of X-rays and raised temperature are not antagonistic. More definite are the results with  $\gamma$ -rays, which also do not affect iodine solution (6 mg. needles filtered with 0.5 mm. of platinum for five days in a solution containing 0.126 gm. of iodine per liter).

Kailan's result that  $\gamma$ -rays decompose solutions of potassium iodide were confirmed, and shown to hold for X-rays also. Attention is drawn to the marked acceleration of the action of the rays produced by the addition of small amounts of acid.

J. G. STEPHENS, M.B. (Syd.), D.M.R.E.

### DOSAGE

Application and Dosage of Bucky's "Borderline Rays" in Ophthalmology. Ilona Krasso. *Strahlentherapie*, 1930, XXXVIII, 358.

The author studied the effect of X-rays of long wave length on the eyes of rabbits. He found that doses as high as 4,000 r produce only an injury to the cornea but do not affect the lens. He feels that the tolerance dose for borderline rays is about twice as high as for ordinary roentgen rays. His therapeutic stud-

ies on human eyes showed similar relations. From 50 to 200 r of a half value layer in aluminum equal to 0.02 mm. were given in the average case. The treatment can be repeated at intervals of from two to fourteen days, up to five times. Satisfactory results were obtained in the following diseases: erosio corneæ; herpes corneæ; keratitis filamentosa, dendritica and punctata superficialis; rosacea of the cornea, infiltrated erosions; superficial ulcer, episcleritis, and scleritis.

ERNST A. POHLE, M.D., Ph.D.

A Biologic Unit in the Dosage of Roentgen Rays. E. Björling. *Strahlentherapie*, 1930, XXXVI, 751.

This paper is based on the assumption that 1 r produces different biologic effects if different wave lengths are used. Measuring methods both for quality and quantity of roentgen rays have been worked out by the author, permitting the expression of the dose in "bio-r." This is the unit of his biologic measuring system which takes the wave length dependence into consideration. The details of the technical procedure and also its theoretical foundations must be looked up in the original.

ERNST A. POHLE, M.D., Ph.D.

Maximum Dose, Fractional Treatment, or Saturation Method? Studies on Mice with Carcinoma. Jens Juul. *Strahlentherapie*, 1930, XXXVIII, 623.

The author studied the effect of roentgen rays and radium applied according to the single massive-dose method, the fractional, and saturation-dose method on transplanted tumors in mice. The technic is as follows: 220 K.V., 2.8 ma., 5 mm. Al, 2.3 cm. F.S.D., 1 S-N. = 6 min.,  $3\frac{1}{2}$  S-N. equal to 1 E.D. The exposures were given as follows: 6 S-N. in one sitting,  $3 \times 2$  S-N. twice weekly,  $3 \times 2$  S-N. once every 2 weeks, and  $3 \times 2$  S-N. once every 3 weeks, or 6 S-N. in one sitting,  $3 \times 2$  S-N. applied twice daily and  $3 \times 2$  S-N. on three successive days. In both groups, the single-massive dose had the most pronounced effect. In observing the epilation following the treatment, it appeared, however, that 6 S-N. given in one sitting always epilated,

while  $3 \times 2$  S.-N., applied every twelve hours, rarely did so. Another series received 6 S.-N. in one sitting, 2 S.-N. six times, applied twice weekly, and then 5 S.-N. in one sitting followed by  $4 \times 2$  S.-N., given once a week.

The results demonstrated that the dose on the skin could be higher with the protracted fractional method without causing injuries, and that the therapeutic effect on the tumor was better than that of a single-massive dose. Similar experiments carried out with radium lead to the conclusion that a more severe reaction follows the application of a high intensity in a short time than the application of a small intensity over a long period. Since the skin and tumor tissue apparently cumulate radiation in a different manner, the fractional dose method is advantageous. It permits the application of a higher total dose within the tumor without damaging the skin.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Dosage in Practice.** Th. C. Neeff. *Strahlentherapie*. 1930, XXXVIII, 322.

The author visited fourteen Radiological Institutes in Germany, Austria, Switzerland, France, and Belgium, and had his ionization instrument calibrated in r-units. It appeared that the calibrations carried out in Germany differed as much as 16 per cent, while the highest variation among all calibrations amounted to 18 per cent. These discrepancies are high if one considers the fact that the measuring instruments available to-day are accurate within 1 per cent. The various precautions necessary to calibrating a dosimeter are discussed in detail; the conditions under which the measurements are carried out are often responsible for the differences in the results. Although the variations found do not interfere with the practical work, the investigator must demand a higher degree of accuracy. Steps are being taken by the Standardization Committee of the German Roentgen Ray Society to remedy the situation.

ERNST A. POHLE, M.D., Ph.D.

## GALL BLADDER (NORMAL AND PATHOLOGICAL)

**Intravenous Cholecystography and Liver Function Determination: Clinical and Roentgenological Value.** Sydney R. Miller and Charles A. Waters. *Southern Med. Jour.*, December, 1930, XXIII, 1079.

The authors add the weight of their experience to the intravenous method of administering the dye, and contend that it is essentially devoid of dangerous reactions, is not time-consuming or complicated, and is more dependable than the oral technic. This series includes cases with severe jaundice, due to cholangitis, common duct obstruction, and severe liver damage following arsphenamine treatment, without any unpleasant reactions. In using the intravenous technic as a liver function test, from 12 to 15 c.c. of blood are withdrawn one-half hour after the administration of the dye, and tested colorimetrically for the percentage of dye retained. The authors' series covers 131 patients, 24 of whom came up for operation. Of these 24, the operative findings agreed with the X-ray findings in 20 cases. Of the 107 patients not operated upon, the clinical symptoms and X-ray findings agreed in 95 cases, or 88 per cent.

The authors conclude that this series is but another confirmation of the extreme value of cholecystography as a method of detecting functional abnormalities, and hence, presumably, diseased conditions of the gall bladder. They contend that the failure of the gall bladder to visualize by the oral method must be checked by the intravenous route, particularly in cases in which the clinical picture is not a clear one of gall-bladder disease.

W. W. WATKINS, M.D.

**Gallstones in the Ampulla of Vater.** E. Starr Judd and James M. Marshall. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1061.

Fenger, many years ago, described the symptoms of stone lodged in the ampulla, the "ball-valve stone of Fenger." A series of 160 cases were reviewed in which one or more stones were found in the ampulla at operation, and in which the stones were not found in

the hepatic or common bile ducts. In 45 per cent of the series, one or more operations had been performed in the biliary system. In several cases, as many as three or four operations had been performed. Periods of relief varied. The most characteristic feature of stone in the common bile duct is the intermittent nature of the symptoms. Osler stressed paroxysms of colicky pain, chills and fever, and jaundice, followed by intervals of comparative or complete freedom from symptoms—or classic symptoms. Duodenal drainage affords a valuable clue as to whether or not bile is passing from the duct into the duodenum. The technic of operation is discussed and some interesting observations at operation review the occurrence of single and multiple stones, and the occurrence of stones in the gall bladder, coincidently with stones in the duct.

CHARLES G. SUTHERLAND, M.D.

**Gall-bladder Visualization in Jaundiced Patients.** Hillyer Rudisill. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1425.

It is quite generally believed that it is not desirable to advise cholecystography in jaundiced patients. Ten jaundiced patients have been among a group coming in a routine manner for cholecystography. In all but one, the examination revealed useful information without ill-effect to the patients. There is no contra-indication to attempted gall-bladder visualization in obstructive or extrahepatic jaundice. In eight of ten jaundiced patients submitted to gall-bladder dye injection, the clinical diagnosis was catarrhal jaundice.

It is advisable to give intravenous tetrathal-ein sodium solution to jaundiced patients as a possible means of helping to differentiate the causes of jaundice.

CHARLES G. SUTHERLAND, M.D.

**Cholecystographic Diagnosis of Papillomas of the Gall Bladder.** B. R. Kirklin. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 46.

Although benign tumors of the gall bladder are rated as rare by pathologists, the Mayo Clinic, during the last seventeen years, has found papillomas in 8.5 per cent of more than

17,000 gall bladders removed surgically. The clinical and pathological significance of papillomas has not been fully determined, but in many cases at the Clinic, even though they were small and not accompanied by definite cholecystitis, they seemed to have a causative relation to the patient's symptoms, for cholecystectomy was followed promptly by relief. By the use of painstaking cholecystographic technic, the author is able to differentiate, roentgenologically, between papillomas and stones. On that basis the diagnosis of papillomas has been ventured in 20 cases, in four of which the diagnosis was confirmed by operation. The especial characteristics, as seen on the roentgen film, in contrast with non-papillomatous lesions, are: unchanging position within cholecystic shadow; small evenly rounded defects, usually marginal and never at the fundic pole; in most instances only one or two visible defects, but when multiple never closely aggregated; often seen only at the twentieth hour (two hours after a fatty meal).

The author concludes that, although only a few cases are presented, the results thus far obtained may have a broad bearing in the future on the diagnosis of tumors of the gall bladder.

J. E. HABBE, M.D.

**Cholecystography by Means of the Oral Administration of the Dye.** Bruno Thom. *Röntgenpraxis*, Jan. 1, 1931, III, 17.

The results of oral cholecystography in 702 cases are evaluated by the author. Only after Kirklin showed that the addition of unfermented fruit juice makes the absorption better, and after a preparation was offered which contained the fruit acid, oral tetragnost (Merck), could this method compete with the intravenous method. In about 15 per cent of all cases in which the oral administration is used, may one expect nausea, vomiting, or diarrhea. Taking the dye only one hour after eating three egg-yolks seems to decrease the nausea, while giving it on an entirely empty stomach seems to induce vomiting much more frequently.

In 73 cases, both the intravenous and oral administration were used. In 8, there was

a definite filling after taking the dye by mouth, while the intravenous method did not show any filling; in 12, the contrary took place. Since intravenous cholecystography usually gives a denser shadow, one should realize that too dense a shadow may obscure small stones, as has happened in this series. A non-functioning gall bladder may be found occasionally in other diseases, probably caused by secretory disturbances of the liver and gall bladder, when the gall bladder itself is normal.

Orator found a non-functioning gall bladder in 60 per cent of 25 cases of gastric or duodenal ulcer; Grebe found 26 per cent. These percentages, however, cannot be correct, in the author's opinion. In order to have a more definite knowledge on this question, a large number of ulcer cases should have a cholecystographic examination. The dye test may show a non-functioning gall bladder also in patients with an exophthalmic goiter or diabetes. According to most writers, a non-filling gall bladder is found in patients with exophthalmic goiter in about 50 per cent of all cases. The author examined six cases and found a non-functioning gall bladder in all of them. The question, whether or not the gall bladder empties itself by muscular contraction, seems definitely settled in the writer's opinion. He has seen definite waves of contraction in a series of films. A roentgenologic visualization of the choledochus is very rare, if the usual technic is used. The author has been able to show it fairly regularly after giving Cholotonon, a preparation which is supposed to contain the hormones of the liver and the extrahepatic system.

H. W. HEFKE, M.D.

#### GASTRO-INTESTINAL TRACT (DIAGNOSIS)

**Enemata: From the Anatomical and Physiological Standpoints.** Silas A. Lewis. *California and Western Med.*, January, 1931, XXXIV, 31.

The author discusses the anatomy of the colon, emphasizing the character of the bowel, especially the angulation at the hepatic and splenic flexures, and the increased musculature of the descending colon. He also emphasizes the amount of residual fluid found after evac-

uation of the enema. The giving of large enemas dilates the cecum and allows the enema to flow into the ileum, carrying with it colonic bacteria. This, the author believes, may be etiologic of ileo-colitis. Large enemas weaken the musculature of the colon and are pocketed behind the splenic and hepatic flexures. The article is illustrated with numerous X-ray cuts.

FRANCIS B. SHELDON, M.D.

**Peptic Ulcer: The Diagnostic Value of the Roentgen Ray before and after Treatment.** Edward S. Emery, Jr., and Robert T. Monroc. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 51.

The authors fully recognize the value of the roentgen examination in the diagnosis of peptic ulcer (in 93 per cent of a series of 510 cases in which the diagnosis was definitely established, an ulcer was demonstrated roentgenologically), but upon analysis of a large series of case records from the Peter Bent Brigham Hospital in Boston, they find the same method of examination much less reliable and helpful in following the course of the lesion. Because after long continued study of many ulcer cases, some showed stationary conditions for years, the opinion is ventured that it may be foolish to advise severe and time-consuming surgical or medical treatment, merely because the presence of a gastric or duodenal ulcer can be shown. As regards the X-ray diagnosis of ulcer, the authors believe the errors in diagnosis to be chiefly those of omission, but even these were found to be surprisingly few.

Retention, determined by the six-hour roentgen examination, was found to be present in 50 per cent of gastric and 44 per cent of duodenal ulcers, but in the majority of the cases, it was small (a trace to 20 per cent). Retention determined clinically agreed closely in 67 per cent of the cases, but in the remaining 33 per cent, the clinical and roentgen retention differed as to the degree present. Hence one would not be justified in advising surgery for relief of obstruction before checking the retention reported present by the roentgen study with that noted by the clinical examination. An analysis of 140 duodenal ulcer cases, treated by several forms of med-

ical and surgical measures, revealed the duodenal deformity persistent upon re-examination roentgenologically following treatment in 94.3 per cent. The small percentage of cases showing disappearance of the duodenal deformity were in every instance treated only medically. In five patients with combined gastric and duodenal ulcer, all but one showed disappearance of the gastric deformity under treatment, but the same number showed a similar or increased deformity of the duodenal bulb.

The authors conclude with the statement that, in their opinion, a diagnosis of healed duodenal ulcer is at present impossible by roentgen examination, and add, rather pessimistically, that this lesion is a very chronic one, rarely cured by treatment.

J. E. HABBE, M.D.

**The Differential Diagnosis of Benign Tumors of the Stomach and Intestines.**  
Franz Schmitz. *Röntgenpraxis*, Dec. 15, 1930, II, 1118.

The roentgenologic findings and clinical history of a patient who had two rather large submucous myomas of the stomach are described. Most benign gastric tumors are polyps, myomas being distinctly rare. Another case is described in which multiple small filling defects were found in the esophagus. On account of their multiplicity and well defined outlines, a benign polyposis was diagnosed. The patient died, with increasing obstruction and cachexia. Inflammatory tumors may simulate a malignancy in the colon, especially when associated with diverticulitis. Even a careful examination of the "mucosa relief" does not always assist in arriving at a positive diagnosis, and, therefore, repeated examinations must be made.

H. W. HEFKE, M.D.

**Roentgen Diagnosis of Gastric Syphilis.**  
Leon T. LeWald. *Jour. Am. Med. Assn.*, Jan. 17, 1931, XCVI, 179.

The author made his first roentgenologic diagnosis of gastric syphilis in 1913. The diagnosis was made prior to the examination of the blood, which was later reported as giv-

ing a four plus Wassermann reaction. The diagnosis was confirmed by operation. The case was evidently one of congenital syphilis and has been re-examined several times, the last time in June, 1930. A second case of congenital syphilis was seen later in 1913. In September, 1916, 11 additional cases were reported by the author and about 40 additional cases have come under his observation, in which the diagnosis of gastric syphilis has been made or suggested from the roentgenologic appearance. The more interesting of these cases are reviewed. Syphilis of the stomach is relatively more frequent in occurrence than the number of reported cases would appear to indicate, and the importance of a correct diagnosis of this condition is not yet thoroughly appreciated. Congenital cases may escape diagnosis owing to the fact that syphilis may not be suspected, and other syphilitic manifestations may be lacking. Diminished acidity of gastric contents and the absence of free hydrochloric acid are explained in some cases by the rapid emptying of the stomach and in others by the involvement of the acid-producing portion of the stomach.

It is inadvisable to make a diagnosis of carcinoma of the stomach or subject a patient to operation for supposed carcinoma of the stomach, especially when the possibility of an extensive resection is under consideration, without submitting the patient to a roentgen examination by a roentgenologist of sufficient experience to enable him to make a differential diagnosis between gastric carcinoma, linitis plastica, ulcer, or syphilis of the stomach. In doubtful cases a diagnosis may be established by determining improvement in the appearance of the stomach on roentgen examination after antisyphilitic treatment has been actively undertaken, especially after using arsphenamine, mercury, and iodides. In some cases surgical intervention may be necessary because of extreme cicatrization, especially involving the pyloric end of the stomach, producing an obstructive lesion. Extensive resection of the stomach should be carefully avoided when the diagnosis of gastric syphilis has been made roentgenologically, or when suspected by the surgeon because of peculiar types of gastric

lesions which differ from those usually encountered in ulcer or carcinoma of the stomach. Syphilitic deformity of the stomach has been proved roentgenologically to disappear after prolonged antisyphilitic treatment, and no recurrence of symptoms has occurred in a series of cases studied over a period of from ten to seventeen years.

CHARLES G. SUTHERLAND, M.D.

**Syphilis of the Stomach.** Luther L. Hill, Jr. *Southern Med. Jour.*, December, 1930, XXIII, 1153.

At present there is a marked variation in the criteria for a diagnosis of gastric syphilis, and, doubtless, many cases reported have been confused with other conditions. Even among pathologists there is considerable difference of opinion as to the anatomical evidence which warrants such a diagnosis. The criteria set forth by Harris and Youmans as being "reasonably conclusive" are: "(1) evidence of organic disease of the stomach, which, on X-ray examination, is indistinguishable from carcinoma; (2) a comparatively young individual; (3) the presence of other evidence of syphilis; (4) a qualified improvement under antisyphilitic treatment; (5) in operative cases, demonstration of tissue changes compatible with syphilis." The demonstration of the lesion in the stomach by the X-ray is essential, because systemic syphilis may give symptoms of stomach disorders, without organic involvement of the stomach.

W. W. WATKINS, M.D.

**Gastric Syphilis: Observations Based on Ninety-three Cases.** George B. Eusterman. *Jour. Am. Med. Assn.*, Jan. 17, 1931, XCVI, 173.

The traditional conception of late or tertiary lesions of acquired syphilis of the alimentary tract is confined almost entirely to those of the mouth, nasopharynx, and rectum. In the light of our present knowledge, based on authentic pathologic and clinical investigations, with the possible exception of the esophagus, which seems rarely affected, it is still an unsettled question as to which organ of the gastro-intestinal tract is most frequently in-

involved. Undoubtedly, routinely made serologic and roentgenoscopic examination of patients with digestive disturbances has led to the eventual disclosure of gastric lesions of syphilitic origin and to a better knowledge of their incidence in the living subject. Gastric syphilis is common in China. The incidence in Russia seems to be high. Then, in order of probable frequency, come France, Austria, Germany, and England.

The diagnostic aspects of gastric syphilis may be summarized as follows: The majority of the patients fell into the period from the second to the fourth decade of life, the average age was about 36 years; the gastric disturbances were usually marked and progressive, with an average duration of two years; the symptoms depended, in a large measure, on the site and extent of the lesion and the existing complications; achlorhydria, or subacidity, especially the former, was the rule; palpable mass, retention, nausea, anorexia, anemia, cachexia, gross hemorrhage, and occult bleeding were infrequent, in contrast to their incidence in carcinoma, a disease in which the laboratory data usually simulated those of gastric syphilis.

The roentgenologic manifestations, although not pathognomonic, were those of circumscribed or diffuse involvement of the gastric wall, rather than an intrusion into the lumen by a growth, which produced contraction of variable degree, stiffening, lessened mobility, and absence of peristalsis. The pylorus was usually gaping; less frequently it was obstructed. The diagnosis was often inferential because of the frequent absence of a palpable mass corresponding to the position of a filling defect, and because of the disproportion between the patient's general condition and the extent of the gastric involvement, as revealed by the roentgenoscopic examination. In 70 per cent the lesion was of the prepyloric type, the defect was concentric, rather symmetrical, and of variable extent upwards. In 22 per cent the lesion was of the median or dumb-bell, hour-glass type, and in the remainder (8 per cent) the involvement was diffuse.

Modern scientific methods of diagnosis and

treatment, coupled with the knowledge gained from histopathologic study of resected material in cases in which operation had been performed erroneously for carcinoma, reveal the fact that gastric syphilis is not as rare as is generally supposed. The disease simulates gastric carcinoma more frequently than any other lesion. In all cases of syphilis in which a demonstrable gastric lesion is present, regardless of the roentgenologic type or extent, the condition should be regarded as syphilitic until it is proved otherwise.

CHARLES G. SUTHERLAND, M.D.

### GENITO-URINARY TRACT (DIAGNOSIS)

#### Unusual Duplication of Renal Pelvis.

Hermon C. Bumpus, Jr. *Jour. Urology*, January, 1931, XXV, 39.

Until recently, whenever duplication of the kidney pelvis occurred, the division was considered transverse, one pelvis being situated above the other. This view was maintained by Young and others. Potter and Sexton believed the division might be longitudinal as well, with one pelvis anterior and one posterior, and demonstrated a case by which their opinion was confirmed. The author reports another case of longitudinal fission, with one pelvis superimposed on the other. A supernumerary kidney must be considered.

DAVIS H. PARDOLL, M.D.

**A Giant Ureteral Calculus.** Frank S. Patch. *Canadian Med. Assn. Jour.*, October, 1930, XXIII, 553.

This is a case report from the urologic service of the Montreal General Hospital. The clinical history is as follows: male, aged 35; pains in left groin; thick urine; history of a blow in the pit of the stomach four months previously; temperature 104°; urinary frequency and burning; urine contains pus. X-ray examination showed a large oval shadow in the left pelvis, in the anatomical situation of the ureter. Cystoscopic examination showed a regular, rounded bulging on the left side of the bladder. Ureteral catheter was obstructed 2 cm. from the mouth of the left ureter. The ureterogram of this side showed

the fluid leaving the catheter, and a thin film spreading around the lower half of the shadow. The diagnosis was left ureteral calculus. At operation the left ureter was exposed extra-peritoneally—greatly dilated, the walls thickened, with a kink just above the brim of the pelvis. A large stone was felt low down in the ureter. An incision was made in the ureter above the calculus, the stone removed by forceps, with great difficulty, and a drainage tube left in the upper ureter, but a probe could not be passed into the bladder. Subsequently there was very little urine drainage through the tube, and no indigo-carmin, injected intravenously, appeared during a five-hour observation.

After two weeks cystoscopy was again performed, and the ureter was found still obstructed in its lower portion. A pyelogram, secured by injection through the drainage tube, showed a greatly distended ureter and kidney pelvis. One week later left nephrectomy and ureterotomy were performed, the ureter being removed down to the bladder. The kidney was found markedly atrophied, and the pelvis and ureter greatly dilated. The report is well illustrated by X-ray reproductions.

L. J. CARTER, M.D.

**Clinical Application of Bladder Tumor Pathology.** Paul W. Aschner. *Am. Jour. Surg.*, October, 1930, X, 67.

The author arrives at the following conclusions, after a very comprehensive study of 285 cases of bladder tumor pathology. In 97.5 per cent of the cases, reliable information regarding the character of bladder tumors is obtained by cystoscopic biopsy. It is chiefly in multiple tumors and papillomatosis that unavoidable failures occur. Biopsy alone does not determine prognosis in cases of malignancy.

In cases in which cystoscopic examination reveals papilloma and there is response to fulguration, a biopsy diagnosis of malignancy is a signal for more radical therapy (radium or surgery). General tumor terminology and clinical requirements may be applied to bladder tumors in a harmonious manner. They may be either benign or malignant. Cell-grading, as a basis for classification, is not as prac-

tical for clinical purposes, and the prognosis, based on this, does not coincide with the late results in this series. A more reliable guide to the gravity of the situation is the presence or absence of infiltration. Resectability depends upon the site of the malignant tumor and influences prognosis materially. Segmental resection of the whole thickness of the bladder wall is the procedure of choice in cases which are considered surgical, following a biopsy diagnosis of carcinoma. Recurrence often results if this procedure is not performed in pedunculated tumors, as gross inspection cannot reveal stalk invasion and tumor cells in the blood vessels at the base.

That papillary carcinoma develops from papilloma in a considerable percentage of the cases is doubtful from clinical observation, yet histological studies tempt one to believe so. Only 30 out of 138 papillary carcinomas failed to show evidence of infiltration. There is a probability that this may represent an earlier stage in the development of the disease. Since other lesions may stimulate neoplasms very closely, it is essential to obtain a biopsy specimen before undertaking radical surgery.

DAVIS H. PARDOLL, M.D.

**Intravenous Urography (Swick Method).**  
Leopold Jaches. *Jour. Am. Med. Assn.*,  
Nov. 8, 1930, XCV, 1409.

Continuing the essay of Swick, the author discusses the roentgenologic features. The present substance, under normal conditions, is excreted as such through the urinary tract within from eight to twelve hours to the extent of from 85 to 95 per cent. Iodism has never been observed. Its tolerance is exceedingly great. From 45 to 65 per cent of the substance is normally excreted during the first two hours. For this reason the roentgenograms show their greatest intensity during this period. The roentgenologic technic is discussed in detail. A comparison of the intravenous method with the cystoscopic or retrograde method favors the intravenous method, with an added advantage that it demonstrates not only the anatomy of the urinary tract, but also its function.

CHARLES G. SUTHERLAND, M.D.

**Experimental Research Concerning Intravenous Pyelography in Pathological Conditions of the Kidneys.** Gerhard Gabriel. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 500.

By radiation of the kidney and by ligation of the ureter, renal artery, and renal vein, the author has attempted to study in experimental animals the pathological conditions which disturb the normal appearance of the urinary tract in intravenous pyelography.

He concludes as follows from these studies:

1. Damage of the kidney by radiation delays the excretion of the dye.

2. Tumors of the kidney which have destroyed a considerable portion of the parenchyma also delay excretion.

3. In chronic blocking of the kidneys excretion is so slow that good visualization of the urinary tract is impossible.

4. Interference with the arterial blood supply of the kidney delays the excretion of the dye.

5. Purulent infections of the renal pelvis and kidney proper affect greatly the excretion of the dye.

6. In paranephritic abscess visualization occurs as long as the renal parenchyma is not involved.

7. Any condition, whether in the ureter or outside it, which delays the passage of the urine from the kidney to the bladder, leads to stasis in the renal pelvis and delayed filling.

8. The normal rapid excretion of the dye is delayed by temporary compression of the ureter. Such a condition sometimes is seen in pregnant animals. Artificial compression from outside the body may be used by the roentgenologist for this purpose; this procedure often results in excellent visualization of the kidney pelvis.

ALAN L. HART, M.D.

**A New Urographic Medium: Emulsified Campidol (an Iodized Rapeseed Oil).** Adolph A. Kutzmann. *Am. Jour. Surg.*, November, 1930, X, 320.

Campidol is an iodized oil containing approximately 44 per cent elemental iodine. To adapt it to urographic use, a stable emulsion



was made using campiodol, acacia, and distilled water. This results in a mixture containing from 10 to 11 per cent elemental iodine, making it equal to sodium iodide for roentgenographic use. Emulsified campiodol, as a urographic medium, is miscible with water. It is inert, non-toxic, non-irritating, and casts excellent roentgenographic shadows, as to detail and intensity, in all parts of the urinary tract. The author has used it in over two hundred and fifty cases and believes it to be superior to sodium iodide for this purpose.

HOWARD P. DOUB, M.D.

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**Excretion Pyelography with Abrodil.** H. Bronner and J. Schueller. *Surg., Gynec. and Obst.*, February, 1931, LII, 254.

The sodium salt of iodo-methane-sulphonic acid, a white crystalline powder, is called "abrodil." This substance, when injected intravenously (20 grams dissolved in 70 to 100 of distilled water), produces a solution which can be sterilized, and its iodine is tightly bound and is not split off within the body. It can be used in the above percentage in pregnant women and tuberculous patients, and appears to be contra-indicated only in those patients suffering from the severest form of kidney insufficiency. This method can be used in ambulatory patients, and also has been used in 15 to 20 per cent solutions for retrograde pyelography. X-ray films are best taken during the first hour after the injection.

DONALD S. CHILDS, M.D.

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**Interpretation of Double Ureters.** Leonard P. Wershub. *Am. Jour. Surg.*, October, 1930, X, 122.

The author reports several interesting anomalies of the ureter. Modern diagnostic methods in urology have been responsible for the increase in the number reported. The embryologic defects are represented by their anomalies. Surgical complications are more prone to develop in these conditions because of the possibility of interference with urinary function, yet this does not imply that all

anomalies are pathologic. Only in cases in which there is obstruction and subsequent infection does renal impairment follow. Duplication may not be complete, the fusion occurring either high up or low down. An abnormally located pelvis, in relation to the kidney itself on pyelography, should lead one to suspect an anomaly.

In duplication of ureteric orifices one should be careful in differentiating the urine recovered by catheterization, as one lobe may furnish a clear specimen, while the other may be cloudy. Clear urine obtained subsequent to a previous specimen of cloudy urine does not necessarily imply a spontaneous recovery from kidney infection.

DAVIS H. PARDOLL, M.D.

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**The Demonstration of the Kidneys with Abrodil, and Some Remarks about the Roentgen Stereoscopy of the Kidney.** W. Teschendorf. *Röntgenpraxis*, Oct. 15, 1930, II, 937.

The author, although not optimistic about the demonstration of the urinary tract by intravenous injection of dyes when he began to use them, comes to the following conclusions: (1) The demonstration of the urinary tract, by means of the intravenous injection of dyes, has the advantage that it is a functional test at the same time (specific gravity test); (2) it makes an examination possible in cases in which introduction of ureteral catheters is not possible; (3) the danger of infection is avoided; (4) it allows the simultaneous demonstration of both kidneys, often not possible by means of the ureteral catheter; (5) it is much less severe for the patient than a cystoscopy.

Uroselectan and abrodil (a new German preparation) have been used. Abrodil is entirely non-toxic, as is uroselectan. Only 20 gm. of the substance are necessary, diluted in 50 c.c. of distilled water. An increase in the amount of abrodil does not increase the density of the shadow, even 10 gm. being sufficient in some cases. Dryness in the mouth and a flushed face are observed after the injection, but are absent when the 20 gm. are

diluted in 100 c.c. of distilled water. A compression bag over the ureters in the sacro-iliac region seems to improve the results. A good filling of the kidney pelvis, however, even with the best technic, is not always possible. Stereoscopic examination of the urinary tract, demonstrated by uroselectan and abrodil, has been a great help, the rather soft shadows of the pelvic and ureteral filling being more marked in the stereogram by the addition. The introduction of a ureteral catheter, with stereoscopic films, seems better than abrodil or uroselectan and stereograms. The introduction of abrodil in a 40 per cent solution into the duodenum did not give a contrast shadow of the pelvis and ureters, probably because the solution was too concentrated. Films of the arm and shoulder, taken during the intravenous injection, show all the veins of the arm up to the subclavian vein. Abrodil might well be used for the demonstration of blood vessels.

H. W. HERKE, M.D.

**Roentgen-ray Diagnosis of Urologic Conditions.** H. King Wade and H. Clay Chensault. *Jour. Arkansas Med. Soc.*, October, 1930, XXVII, 97.

These authors summarize a short general paper on the use of the X-ray in urology, as follows: (1) Urology and roentgenology are inseparable from a urologic diagnostic standpoint; (2) modern urologic X-ray equipment is essential in the diagnosis of urologic conditions; (3) the urologist may assist in the diagnosis of obscure surgical and gynecological conditions by means of the roentgen ray; (4) the X-ray is invaluable in the pre-surgical location of calculi in the genito-urinary tract.

W. W. WATKINS, M.D.

**Bone Suppuration and Renal Calculi in Children.** Milton C. Borman. *Am. Jour. Dis. Child.*, October, 1930, XL, 804.

A case of a boy, aged 9, with bilateral renal and ureteral calculi, and an overwhelming osteomyelitis of the tibia, is reported. Hematuria was the only clinical evidence of uro-

lithiasis. The calculi remained unsuspected and undiscovered until necropsy, at which time they were found to be composed of practically pure calcium phosphate with a small amount of organic matter. Less than 50 per cent of urinary calculi are so composed, according to Thomson, and in a series of 203 cases, reported by Thomas and Tanner, only one showed calculi in both kidneys and ureters.

The author reviews references in the literature concerning the incidence of renal calculi in infancy and childhood, and their frequency in patients with fractured spine and with bone suppuration. He states that the calculus formation in his case was probably definitely dependent on the osteomyelitis and was not simply an associated incidental condition. It is important, therefore, to suspect urolithiasis in cases of bone suppuration in children and adults.

F. B. MANDEVILLE, M.D.

**Para-urethritis.** Sidney J. Silbar. *Jour. Urology*, January, 1931, XXV, 85.

The author finds that para-urethral ducts are a cause in the chronicity of gonorrhea. They may act as foci of infection and cause a recurrence of an infection. The infection may linger within their portals over a long period of time. Their occurrence, while uncommon, is greater in cases of normal meatus than in hypospadias.

An indispensable aid in recognizing and locating the para-urethral ducts and their ramifications is the use of the roentgenogram. An opaque solution injected into the orifice of the ducts or the urethra, when it communicates, may be employed, and both antero-posterior and lateral views taken, the same principle being employed as with a sinus or fistulous tract. The treatment consists of cauterization of the duct and its complete obliteration whenever possible.

DAVIS H. PARDOLL, M.D.

**Intravenous Urography by Means of the Sodium Salt of 5-Iodo-2-Pyridon-N-Acetic Acid.** Moses Swick. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1403.

A comprehensive review of the experi-

mental work preceding this preparation is interesting. This work was begun with N-methyl-5-iodo-2-pyridon, synthesized by Professors Binz and R  th. The study of its excretion through the kidney and into the bile, and its iodine content (54 per cent) led to the thought that the substance might be applicable for roentgenologic purposes. Simultaneous studies of its excretion, limited to determination of the iodine component, revealed about 75 or 80 per cent of the injected iodine in the urine in from twelve to sixteen hours.

The experience with this substance brought out the need for a modification, possessing better tolerance and greater solubility, so that a larger dose could be administered. When a preparation having a lower iodine content, and the sodium acetate group substituted for the methyl, was furnished by Professor Binz, the clinically applicable and successful substance, 5-iodo-2-pyridon-N-acetate of sodium, was finally obtained. The sodium salt (42.2 per cent iodine) is non-toxic, very soluble in water, and neutral in its reaction. The tolerance for this compound is exceedingly great. The blood urea, phenolsulphonephthalein, the indigo carmine, and the dilution and concentration tests are of great assistance in establishing the contra-indication to the application of this method in a given case of bilateral advanced kidney disease. Where the blood urea is high, and the concentrating power of the kidney poor, the method yields few anatomic data and becomes not only superfluous but perhaps is attended with danger. The administration and dosage are given in detail. The reactions, contra-indications, and application of the method are interestingly discussed.

CHARLES G. SUTHERLAND, M.D.

**Roentgenologic Diagnosis in Tuberculosis of the Kidney.** B. H. Nichols. *Texas St. Jour. Med.*, August, 1930, XXVI, 283.

This paper omits the clinical, urinary, and cystoscopic findings in kidney tuberculosis. It discusses the types of tuberculosis, their pathology, and the use of pyelography. The author summarizes as follows:

1. In every suspected case of renal tuber-

culosis, stereoscopic films should be made, showing the size, shape, and position of both kidneys.

2. Irregular calcifications of varying density are characteristic of renal tuberculosis in the process of repair, as are also calcific deposits in the walls of the ureters.

3. A pyelogram can be made of the suspected kidney without hesitation, even though tubercle bacilli are found in the urine.

4. When a diagnosis is made of tuberculosis in one kidney, it is necessary, in order to decide upon the advisability of operation, to determine the condition of the other kidney.

5. A pyelogram of the unaffected kidney can be made by the intravenous route, without risk of infection, and both kidneys may thus be shown at the same examination.

6. The presence of a localized destructive lesion near or at the base of a papilla, with the pelvis and other calices normal, is an indication of early renal tuberculosis, particularly if the affected area has irregular, serrated edges.

7. Multiple strictures of the ureter, in combination with pyonephrosis which has apparently involved only portions of the kidney, are highly suggestive of tuberculosis.

8. In advanced cases there may be marked pyonephrosis with areas not unlike an ostrich plume. These are characteristic.

9. The pyonephrosis may be complicated by hydronephrosis, particularly in cases in which there is stricture of the ureter.

10. A perinephritic abscess, with a fistula into the intestine, is apparently always tuberculous.

11. The final diagnosis of renal tuberculosis must always be confirmed by the finding of tubercle bacilli in the urine, or by a characteristic history and confirmatory cystoscopic findings.

12. The appearance in the roentgenogram of a more or less characteristic pathologic picture, together with the presence of tubercle bacilli in the urine from the catheterized kidney, will almost always confirm the diagnosis of renal tuberculosis.

13. The best results are secured when the roentgenologic examination is evaluated by a

competent roentgenologist, and the history, physical examination, and cystoscopic findings are interpreted by a capable urologist.

W. W. WATKINS, M.D.

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**Uroselectan: Reactions Accompanying its Practical Application: Report of Cases.** George W. Hartman. *California and Western Med.*, December, 1930, XXXIII, 867.

The author reports a number of cases in which he has used uroselectan intravenously as an opaque medium for outlining the urinary tract. All his patients complained of pain at the site of the injection (in mid-arm or shoulder); however, one patient, in which the gravity method was used, did not complain of as much pain.

Among his conclusions, the author finds that this method is valuable in patients in whom there is an obstruction at any point that would prevent the passage of an instrument, and would also include stricture, double ureter, prostatic hypertrophy, bladder diseases, hemorrhage, ruptured kidneys, infection, fistula; and in children. In two cases reported there was a marked anaphylactic reaction. He suggests that caution be used in thyrotoxicosis, pregnancy, active tuberculosis, acute or chronic renal disease, and circulatory disturbances. Uroselectan will not find a dead kidney. There is no danger of over- or under-distention.

FRANCIS B. SHELDON, M.D.

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**Anomalous Renal Rotation and Associated Anomalies.** William F. Braasch. *Jour. Urology*, January, 1931, XXV, 9.

The author presents a very interesting and comprehensive paper on this subject. Fusion, ectopia, rotation alone, and torsion of the kidney; also, embryonic pelves are considered. Anomalous rotation is apparently an important etiologic factor in the pathologic complications which frequently occur with renal anomaly. This condition is most frequently observed with renal fusion and congenital dystopia, although it may occur without any other evidence of renal anomaly. It may be

the cause of urinary stasis and pyelectasis, with resulting renal pain, and may be regarded as a distinct clinical lesion. When rotation of the kidney occurs, secondary to acquired factors, the term "renal torsion" is employed to distinguish it from anomalous rotation. The absence of other evidence of embryonic deformity aids in the recognition of this condition clinically. The so-called embryonic or congenital pelvis is characterized by a sacculated, elongated pelvis, with multiple abbreviated calices extending laterally, and an elongated, cephalic calix. Pain in the kidney of obscure etiology frequently is observed with anomalous rotation, although surgical exploration may disclose little evidence of gross pathologic change other than anomaly.

The treatment consists in the removal of all obstruction to urinary flow. Aberrant vessels or surrounding tissues producing tension on the pedicle or ureter, either permanently or temporarily, are removed. Occasionally resort must be had to nephropexy, plastic repair, or nephrectomy. Hydronephrosis or calculi are the most frequent complications and, if present, require the necessary procedure.

DAVIS H. PARDOLL, M.D.

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**Intravenous Urography with Uroselectan.** John Duff. *U. S. Naval Med. Bull.*, October, 1930, XXVIII, 715.

The introduction of uroselectan for intravenous urography is the most important accomplishment of this decade in urology. Uroselectan contains 42 per cent of organically combined iodine, and the formula is that of a sodium salt — 2-oxy-5-iodopyridin-N-acetic acid. It is freely soluble in water and when injected intravenously is excreted by a functioning kidney in sufficient concentration to give contrast on an X-ray film. The method is particularly valuable when there is partial or complete obstruction of the ureter due to stone, stricture, or tumor, because under these conditions the shadow is quite dense on account of the mechanical retention and concentration of the substance.

At the James Buchanan Brady Foundation of Urology of the New York Hospital no se-

rious reactions have been observed. At the New York Hospital the first film is made in five minutes, the second in fifteen minutes, the third in half an hour, the fourth in one hour, the fifth in two hours, and the sixth in three hours. Von Lichtenberg recommends that the first film be taken in fifteen minutes, the second in forty-five minutes, and the third in one one-half hours. On an average the best film is obtained thirty minutes after injection.

W. W. WATKINS, M.D.

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**Diagnosis and Treatment of Tuberculosis of the Genital Tract.** J. Dellinger Barney, J. Laxton Watson, and Simeon Elliott. *Am. Jour. Surg.*, October, 1930, X, 84.

It is conceded by all that genital tuberculosis is but another local manifestation of a primary focus elsewhere in the body, this focus being generally in the lungs or bronchial glands. Whether or not urinary or genital lesions precede one another cannot be ascertained; however, they are not infrequently associated with one another. Hence, it is inadvisable to remove the entire seminal tract in cases of genital tuberculosis, if renal complications are suspected or likely to be present.

It is a fact that in juvenile patients the prostate and epididymis are less frequently attacked by tuberculosis than in the adult, due, no doubt, to the lack both of function and physical development at this time of life. There is some doubt in the authors' minds, based upon both autopsy material and hospital patients, regarding the priority of the prostate in genital tuberculosis. The diagnosis of tuberculosis of the epididymis usually yields the characteristic diagnostic features of induration, enlargement, nodularity involving especially the lower pole, and, but insignificant, pain or tenderness. The vas may be thickened and beaded. Most important is the presence of a healed or active sinus. Hydrocele may mask the scrotal pathology, and rarely tubercle bacilli may be demonstrated in the aspirated fluid. Other conditions must be differentiated. Rectal examination will usually reveal the accompanying changes in the

vesicles and prostatic lobe on the side affected, but these may be absent.

The treatment depends almost entirely on what the surgeon believes to be the primary focus of the disease. If the prostate and seminal vesicles are thought to be the point of origin, radical and extensive surgery, with the entire removal of the genital tract, will be advocated. The opinion regarding such a radical procedure, however, varies, some advocating no surgery at all. The authors have had gratifying success with conservative surgery. A modified technic is employed in performing an epididymectomy on the side affected, with ligation and partial excision of the vas on the opposite side, even though it were free from disease at the time of operation; thereby the usual involvement at a later date by tuberculosis of the side not operated upon is prevented, although if present but unrecognized at the time, it will also require removal. This procedure has been followed by comfort and the retrogression of pathological processes in the prostate and seminal vesicles to the point of clinical cure. In addition, hygienic and supportive measures, commonly employed in the treatment of phthisical conditions, are to be rigidly adhered to, together with heliotherapy and tuberculin post-operatively.

DAVIS H. PARDOLL, M.D.

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**Uroselectan Urography.** Milton Weinberg. *Southern Med. and Surg.*, December, 1930, XCII, 874.

Uroselectan for intravenous urography is in its infancy, but there is enough evidence to show that it will be a valuable aid in urological work. The technic is described. Sufficient information may be secured in the first roentgenogram taken ten minutes after the injection to obviate the necessity for further films. On the other hand, in poorly functioning kidneys, twenty-four hours may elapse before a shadow appears. The chief advantages are: (1) Ease of administration; (2) avoidance of discomforts of the cystoscope; (3) a more natural appearance of structures, if good roentgenograms are obtained; (4) use in patients who cannot tolerate cystoscopy; (5) use in pa-

tients who, because of some anatomical abnormality, cannot be examined by the cystoscope; (6) use in cases in which ureteral orifices cannot be found; (7) use in cases in which inflammation contra-indicates cystoscopy; (8) use in children. Obviously the method fails to outline the urinary tract below an obstructing lesion, and, in this and many other cases, it must be supplemented by cystoscopy.

W. W. WATKINS, M.D.

### GENITO-URINARY TRACT (THERAPY)

**Present Status of Electrosurgery and Diathermy in the Treatment of Diseases of the Genito-urinary Tract.** Abraham G. Fleischman. *Am. Jour. Surg.*, October, 1930, X, 116.

The author cites his experience with diathermy in various genito-urinary conditions over a period of seven years. The technic employed is given, together with illustrations. In order to obtain successful results with this form of therapeutic aid, one must be accurate in the diagnosis of the condition to be treated, possess the proper high frequency machine, with suitable electrodes, and have an exact understanding of the basic principles of high frequency currents.

DAVIS H. PARDOLL, M.D.

**Consideration of the Surgical Procedures in the Treatment of Malignant Disease of the Urinary Bladder.** Verne C. Hunt. *Am. Jour. Surg.*, October, 1930, X, 69.

The author confines himself to the consideration of the more or less extensive lesions of the bladder which fail to respond to transurethral treatment and demand surgical procedures. In the truly inoperable lesions the greatest prospects of cure and of palliation may be expected from the combined use of surgery and physical agents. Of 480 graded epitheliomas of the bladder, 58 per cent were malignant, graded 3 or 4 (Broders' index). Lesions of the base of the bladder are more malignant than those of the dome or lateral wall. Experience shows that some of the physical agents are more effective in the treat-

ment of the highly malignant cases, because of their greater radiosensitivity. The lesions of lower grade of malignancy are less apt to infiltrate and extend extravasically and, therefore, warrant more extensive surgical procedures, with reasonable assurance of a cure. The author is emphatic in his preference for surgery in operable malignancy of the bladder, and the results thereof are most successful. However, surgery is seldom justified when the percentage of risk is relatively higher than that of the prospect of cure.

Tumors of the lateral and posterior walls and dome of the bladder are best excised by cautery. When infiltration is present, resection may be done, including immobilization of the bladder where necessary. Tumors of the base require consideration of the ureters. Occasionally the ureters are not encroached upon and resection is possible without either resection and ligation or resection and re-implantation into the bladder. The mortality rate was found to be lower in the former.

In cases in which cystectomy is indicated, the ureters should be transplanted into the sigmoid (C. H. Mayo and Coffey methods), one at a time, preliminary to cystectomy, thereby establishing good renal function and satisfactory urinary control, with the ureters in the sigmoid. Cystectomy may then be performed several weeks later, entirely confined as an extra-peritoneal operation.

DAVIS H. PARDOLL, M.D.

### GRENZ RAYS

**The Effect of Grenz Rays upon the Skin: Histological Investigations.** Karl Herxheimer and Erich Uhlmann. *Arch. f. Dermat. u. Syphilis*, May, 1929, CLVII, 467.

Biological and clinical investigations have shown that Bucky's Grenz rays produce specific effects, as compared with other types of radiation, especially roentgen rays. The authors made a histological examination of radiated skin and found that the Grenz rays penetrate into the skin to a very limited degree. For small doses, which correspond to about one-half of an erythema dose, the influence of radiation upon the epithelium consists in an extensive loosening up of the tis-

sue, in a vacuolization of the cell nuclei, casually in a complete absence of the net structure of the protoplasm, a complete acanthosis and often in a hyperkeratosis and a parakeratosis. Changes in the cutis, however, could not be observed. These effects, which were observed from a histological examination, closely resemble those produced on the skin by ultra-violet radiations. If, however, Grenz-ray doses, which are larger than the erythema dose, are applied, the effects, observed macroscopically, are identical with those produced by overdosage with roentgen rays. Microscopic examination revealed changes in the stratum granulosum and stratum spinosum, together with definite alterations in the basal cell layer and the corium, these alterations being especially manifested in the damage to the endothelium and the adventitious cells of the vessels. The distinction between Bucky's Grenz rays and other types of radiation is therefore justified.

O. GLASSER, Ph.D.

The Absorption of Grenz Rays in Air. Heinz-Theodor Meyer. *Strahlentherapie*. 1930, XXXVIII, 778.

The absorption of Grenz rays in air and the resulting changes in penetration of the remaining beam were studied by the author for potentials from 6 to 12 K.V., by means of an integrating dosimeter. The ionization chamber was independent of the wave length in the region examined. Aluminum filters of from 0.01 mm. to 0.055 mm. thickness were used as absorbers. The results are shown in a number of graphs. It appears that the narrowing of the beam, due to an increase in the focal distance, is more pronounced at higher potentials. For low potentials, the change in the penetration due to air absorption is so small that it is negligible for practical purposes. Since the quality of radiation is greatly dependent upon the thickness of the Lindemann window, the relations between tube potential and penetration of the beam should be determined for each tube by measurements of the half value layer in either aluminum or cellophan. The same holds for the dose curves at different focal distances. Due to the in-

creased absorption in the window, with increasing age of the tube, such measurements should be carried out at least every 100 hours of usage.

ERNST A. POHLE, M.D., Ph.D.

## GYNECOLOGY AND OBSTETRICS

Roentgen Examination of the Female Urethra, Specially in Cases of Prolapse and Incontinence. Einar Thomsen. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 527.

The author describes the technic used in visualizing the female urethral tract on roentgenograms. Two methods are used: one consists of applying a barium paste to the urethral walls, and the other of injecting lipiodol while an exposure is made. He illustrates and describes the changes in the course of the urethra, with structural weaknesses in the pelvic floor.

M. J. GEYMAN, M.D.

Low Voltage X-ray for a Therapeutic Menopause. J. Craig Potter. *New York St. Jour. Med.*, Aug. 1, 1930, XXX, 915.

This author calls attention to the fact that the artificial menopause was produced in thousands of cases before the advent of high voltage machines, and that Hanks is still using low voltage for this purpose. Her technic is a kilovoltage of 100, 5 ma., 10-inch distance, 25 mm. copper filter, cross-firing through four areas, for an average of nine minutes to each area. Treatment is given each month after menstruation, half the treatment being given one day, and the other half two days later. An average of three treatments was required to produce a menopause.

W. W. WATKINS, M.D.

Menstrual Headaches. Charles L. Martin. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1930, XXIV, 267.

In reviewing the histories of gynecological cases sent in for radiation therapy, the author has found that severe recurrent headache, associated with menstruation, has appeared many times as one of the major symptoms

bringing the patient to a physician. One combination of symptoms, consisting of menstrual headache characterized by pains in the occipital or frontal regions, nausea and vomiting, relieved during pregnancy, has occurred frequently enough to indicate the possibility of a specific underlying causative factor. He holds that this type probably has an endocrine origin, and may be partially or completely relieved in a certain number of women past the age of forty by the production with irradiation of an artificial menopause, but that the use of castration in younger women seems of doubtful value and may even accentuate the symptoms. The literature on the subject is reviewed and six cases cited.

J. E. HAMME, M.D.

# **The Sterilization of Women by Roentgen Rays.** G. Fritsch. *Strahlentherapie*, 1930, XXXVIII, 739.

The author describes the development of the technic for roentgen sterilization in his clinic. At present two tubes are used simultaneously; the anterior and posterior fields are  $17 \times 17$  sq. cm., and the surface dose amounts to 492 r per area (170 K.V., 30 cm. F.S.D., 1.2 mm. Cu + 1.0 mm. Al, H.V.L. in Cu = 1.5 mm.). This corresponds to approximately 417 r in 10 cm. depth. Only in very rare cases, the patients treated with this technic developed a faint erythema.

ERNST A. POHLE, M.D., Ph.D.

# **The Roentgen Ray as an Adjunct in Obstetric Diagnosis.** Harvey B. Matthews. *Am. Jour. Obst. and Gynec.*, November, 1930, XX, 612.

The author calls attention to the fact that radiography is insufficiently employed in obstetric and gynecologic diagnosis. He enumerates the conditions in which the X-ray is a valuable adjunct in obstetrical diagnosis, as follows:

*Those relating to the maternal pelvis:* (1) deformities; (2) pelvimetry; (3) bony or calcified pelvic tumors; (4) separation of the pubic symphysis; (5) amount of healing after pubiotomy.

*Those relating to extra-uterine pregnancy:* (1) tubal pregnancy; (2) abdominal pregnancy.

*Those relating to intra-uterine pregnancy:* (1) diagnosis of pregnancy before other characteristic signs and symptoms appear; (2) diagnosis of pregnancy as early as the fourteenth week; (3) multiple pregnancy; (4) presentation and position of fetus; (5) cephalometry; (6) death of fetus; (7) monsters, anencephalus, hydrocephalus, etc.; (8) spina bifida and other skeletal defects; (9) syphilis of fetal bones; (10) hydatidiform mole (by exclusion); (11) intra-uterine fractures; (12) osteogenesis imperfecta; (13) illegitimate pregnancies in which no examination can be made; (14) diagnosis of pregnancy, presentation, and position in very large fat women, 200 to 300 pounds; (15) routine examination should be made before cesarean section to determine if the child is normally formed.

*Those relating to pelvic tumors simulating pregnancy:* (1) fibroid tumors; (2) myomas and pregnancy; (3) ovarian cysts, particularly dermoids.

*Miscellaneous conditions:* (1) spontaneous version; (2) pseudocyesis; (3) mechanism of labor; (4) mode and method of separation of placenta (Warnekros); (5) lithopedion; (6) location of placenta (amniography, method of Menees, Miller, and Holly); (7) proof of extra-uterine life (Vogt).

With regard to dangers to the fetus, the author, an obstetrician, says: "We feel sure that no pregnancy, regardless of its stage of development, is damaged by diagnostic roentgenology properly carried out."

JACOB H. VASTINE, M.D.

# **Radium in Gynecology.** Sidney Forsdike. *British Med. Jour.*, Sept. 20, 1930, No. 3637, p. 468.

The author in this article, by demonstrating the startling differences in technic in vogue at present in radium therapy, is trying to stimulate research in this field, in order that our present knowledge, which is still in its infancy, may be multiplied and some uniform therapy arrived at. He sketches a brief outline of the history of radium in medicine:



how the enthusiasm and unsubstantiated claims of thirty years ago were followed by a period of complete disillusionment in five or six years when radium treatment was left to the few who still had faith; how we are now in the second advent, and the enthusiasm displayed suggests that history is repeating itself. At the present time responsible men are making themselves answerable for statements that from 70 to 80 per cent of early cancers are curable by radium; such claims may possibly be prophecy—they are not history. There is a glut of hastily written books on treatment by radium, and a still greater stream of reports of cases treated within the year. As a result of this present-day enthusiasm sired by our profession and nourished by the press, enormous sums of money have been utilized to purchase quantities of radium for clinical work, without one milligram being allocated for biological research. One would suppose that there was nothing unlearned of the effects of radium upon living tissues, and that, given the supply, the disappearance of the cancer was only a matter of application. A certain amount of work has been done upon normal tissues, tissue cultures, and animal tumors. The knowledge gleaned from these sources is of great value, but it must be multiplied a hundredfold before we are in a position to direct the gamma ray with precision and certainty.

The following problems are discussed: (a) whether radium acts directly upon the cell or upon the stroma, and the importance of this question as affecting the dose to be employed; (b) the value of metal screens, and the wide divergence of opinion among such authorities as Cade, Larkin, and Simpson for the absorption of 99.9 per cent beta rays; (c) the problem of split doses—whether the dose should be applied continuously or divided into two or more exposures. Lazarus-Barlow's experiments on the question of a large dose acting for a short time, having the reverse effect from a relatively small dose acting for a longer time on squamous and columnar epithelium, are discussed; (d) the various methods in use in the treatment of regional glands are so divergent that the urgent need of organized research in this direction is ob-

vious; (e) in the production of artificial menopause, there is a difference of opinion not only as to dosage but as to whether it is the endometrium or the ovary that is affected.

With regard to fibroids, the only exception to the rule of excision is in cases in which hemorrhage is the cardinal symptom. In the treatment of cancer of the cervix it is slowly being recognized that the early results are not permanent in the majority of cases, and, therefore, not worth recording except as evidence of the value of radium for palliative treatment.

The author, while remaining a believer in radium, is convinced that to-day surgical treatment offers the patient a better chance of cure.

W. D. MACKENZIE, M.D.

The Present Value of Irradiation Therapy in Gynecology. Fritz Heimann. *Med. Klinik*, Oct. 17, 1930, XXVI, 1545.

The value of irradiation therapy in gynecologic diseases is considerable; it is one of the most important therapeutic means in this field. Many hundreds of myomas have been treated by irradiation in the author's clinic. The amenorrhea could be induced in almost all cases; only twice, a malignant degeneration was observed and only a few times a renewed growth of the myoma after some years. Surgical removal is practised in questionable cases and in very large tumors. In about 7 per cent of the patients, uterine bleeding was noticed again, but was rarely excessive, most of it appearing as normal menses.

The results of irradiation therapy in myomas are excellent. The severity of climacteric symptoms, caused by irradiation or surgery, seems in either case the same. One must know that the menses may appear once or twice after the roentgen treatment. Excessive menstruation in young women should not be treated by means of irradiation; the danger to the germplasm is too great. Temporary castration is used only in tuberculosis or gonorrhea, as the chances for a later pregnancy are poor.

Roentgen treatment of the spleen in exces-

sive uterine bleeding has impressed the author favorably, and the method is simple. In these benign disorders only roentgen rays are used, as radium has certain technical disadvantages. In amenorrhea and sterility, caused by ovarian dysfunction, a small dose of roentgen rays appears to be of benefit in some cases. No damage is done if one is sure of the amount of irradiation. In climacteric symptoms a small dose of roentgen rays to the hypophysis and thyroid will often achieve good results, when all other therapeutic means have been exhausted. The author's standpoint in the treatment of uterine carcinomas is, that all operable cases should be operated on, that post-operative roentgen treatment is of great value, and that inoperable cases should be treated radiologically.

H. W. HEFKE, M.D.

**Newer Methods of Roentgenographic Contrast Diagnosis in Obstetrics and Gynecology.** Julius Jarcho. *Med. Jour. and Rec.*, Oct. 15, 1930, CXXXII, 395.

The author has been using the combination of pneumoperitoneum followed by oil and has designed an apparatus for this purpose. For the pneumoperitoneum, from 800 to 1,500 c.c. of oxygen or carbon dioxide are first injected by the transuterine route if the tubes are patent, otherwise by the abdominal route. The oil is injected through the cervical canal. After 3 c.c. is injected the first roentgenogram is made; then additional films after 5, 8, 10, or even 15 c.c. of oil. Either method may be used alone, or a combination, when one method will not give the desired information. In this way the clinician may map out the pelvic viscera, or outline the inside and outside of the uterus. The same procedure often shows the tubes and normal ovaries, while neoplasms of the uterus and adnexa are often plainly shown. The diagnosis is thus more precise, and often enables one to make an intelligent choice of method of treatment, whether surgery or radiation. Oftentimes when an operation would sacrifice the uterus and make child-bearing impossible, patients will choose irradiation. The procedure can be

carried out by a gynecologist or by a radiologist, preferably by the two together. By using strict asepsis and gentleness of technic, complications will be avoided, and the co-operation of the patient secured.

W. W. WATKINS, M.D.

**On the Therapy of Fibroids and Hemorrhagic Metropathy in the Women's Clinic at the University of Würzburg, 1923-28.** Paul Uebel. *Strahlentherapie*, 1930, XXXVIII, 438.

This statistical paper does not lend itself well to abstracting. In view of the enormous material there, it is recommended for study in the original. Only a few of the principal points can be mentioned here. Sterilization by roentgen rays was carried out by applying one anterior and one posterior field. The dose effective in the ovaries amounted to 275 r. In many cases, it was not necessary to give as high a dose. Sometimes permanent amenorrhea was obtained following the application of about 180 r in the ovaries. Temporary amenorrhea required about 160 r. The equivalent radium doses were 3,000 mg.-hrs. for permanent amenorrhea, and about 1,500 mg.-hrs. for temporary amenorrhea. In cases in which there was suspicion of a sarcoma, from 4,000 to 5,000 mg.-hrs. were given intra-uterine. This dose has been increased lately to 7,000 mg.-hrs. or 830 r with roentgen rays. If roentgen and radium rays are combined, about one-half of the full dose of either agent was used.

Only a few cases were operated on. The indications for operation were indefinite diagnosis, young age of the patient, pedunculation of the fibroid or incarceration, excessive size of the fibroid or degeneration. The entire material is subdivided into clinic patients and private patients. A total of 318 private patients were observed during the period from 1923 to 1928. Two hundred and three had a fibroid, and 115 had hemorrhagic metropathy. Of the fibroids, 17 were treated by curettage, 142 by irradiation, and 44 by operation. The respective figures in the group of hemorrhagic metropathy were 11,104, and none. A total

of 246 cases, namely, 142 of fibroid and 104 of hemorrhagic metropathy, were irradiated. In the fibroid group, 127 had permanent amenorrhea and 15 temporary amenorrhea. The respective figures for the hemorrhagic metropathy cases were 76 and 28. Of a total of 730 clinic cases, 384 had a fibroid and 336 hemorrhagic metropathy. Six hundred and forty-five were irradiated and 85 operated on. In the fibroid group, 330 were irradiated, 45 operated on, and 19 curetted. The respective figures for the hemorrhagic metropathy were 315, none, and 21. Of the 330 irradiated fibroids, 271 had permanent amenorrhea and 59 temporary amenorrhea. The respective figures for the hemorrhagic metropathy group were 261 and 54. The average hospitalization of private and clinic patients was nine days for radiation therapy and nineteen days for uncomplicated operation.

The author states, in conclusion, that radiation therapy of fibroids and hemorrhagic metropathy has not only given good results in their cases but should be used more in preference to operation.

ERNST A. POHLE, M.D., Ph.D.

### HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Far-reaching Effects of Gamma Rays and Short X-rays upon the Human Heart: Electrocardiographic Results of Cancer Treatments Given without Direct Irradiation of the Heart. J. E. Gendreau. *Ann. Surg.*, January, 1931, XCIII, 476.

Cardiovascular disturbances produced by large doses of gamma rays and short X-rays, even when the heart itself has not been directly treated, are accompanied by symptoms of dyspnea, tachycardia, general fall of blood pressure, and asystolia in very serious cases. The author has used electrocardiograms before, during, and after treatments by radium and X-rays. Many records were taken in cancer cases in which the irradiation area was not directly over the heart. In each case the changes are appreciated by comparison with the tracings taken before treatments. The records show the action of the gamma rays and the X-rays upon the heart at a distance; by

additional *P* waves, and impure flutter; by flattening of the *P* waves, and auricular fibrillation; by abnormal *Q R S* complexes, in general with lower voltages and reduction of the tracings to a line, occasionally with maximum voltages—very deep *Q* and *S* deflections; by deep inverted *T* waves, sharp and rounded, with occasional notchings in the ascending branch. *R T* is constant but *T P* is generally increased and the resulting rhythm slower immediately after a treatment. In premature ventricular contractions on the contrary, *T P* is greatly reduced and *P* immediately follows *T*. The extra systole is generally succeeded by the compensatory pause. Tachycardia is less common than bradycardia.

Electrocardiograms may be useful in the direction of a cancer treatment by irradiations.

F. B. MANDEVILLE, M.D.

The Effect of Amyl Nitrite on the Size of the Heart and the Width of the Aortic Shadow as Determined Roentgenologically. William A. Brams and Herman A. Strauss. *Am. Jour. Med. Sci.*, November, 1930, CLXXX, 618.

In 21 patients the size of the cardiac and aortic shadows was studied roentgenologically before and after the administration of amyl nitrite, including 6 normal persons and 15 with arteriosclerosis. The transverse diameter of the heart was reduced in 18 patients, regardless of whether or not arteriosclerosis or hypertension was present. The width of the aortic shadow was increased in 13 patients. This result also seemed to be independent of the condition of the peripheral vessels or degree of blood pressure.

W. W. WATKINS, M.D.

The Size of the Heart in Goiter: A Tele-roentgenographic Study. Lewis M. Hurxthal, O. J. Menard, and M. E. Bogan. *Am. Jour. Med. Sci.*, December, 1930, CLXXX, 772.

The question of cardiac enlargement from hyperthyroidism has long been unsettled, and many statements have been made without adequate statistical data. A study has been made

of 100 patients with hyperthyroidism and a corresponding number of normal controls. Radiographs were made at a seven-foot distance, and studies made on the basis of age, sex, type of goiter, presence of accompanying heart disease, etc. No definite relationship was found between the duration of the disease or loss of weight and size of heart; cardiac enlargement showed a fairly direct relationship to age and coincident cardiovascular disease; the number of enlarged hearts was practically the same in both toxic and non-toxic goiters; if hyperthyroidism causes enlargement or hypertrophy and dilatation, it is slight.

W. W. WATKINS, M.D.

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### HODGKIN'S DISEASE (DIAGNOSIS)

An Analysis of the Lymphadenopathy Question, with Special Reference to Hodgkin's Disease and Tuberculosis. Fred W. Stewart and Charles A. Doan. *Ann. Surg.*, January, 1931, XCIII, 141.

The authors quote: "Our knowledge of Hodgkin's disease has been clarified or rendered more obscure—depending on the point of view—since Sternberg demonstrated the close association of the disease with tuberculosis, and from that time on the tubercle bacillus has never been satisfactorily dissociated from the Hodgkin's picture." Studies are cited which have tended more and more to favor the concept that Hodgkin's disease is a special manifestation of tuberculosis. Recent studies disclose that animals showing a high physiological level of monocytes in contrast to lymphocytes are relatively more susceptible to acute, progressive tuberculosis than those having a low M/L index. The epithelioid cell of the tubercle has its origin from the monocyte, and epithelioid cells as identified in the supravital technic have been found as a part of the cellular reaction in Hodgkin's nodes. The newer bacteriologic studies of Petroff in the dissociation of various pure strains of avian, bovine, and human tubercle bacilli are important. The correlated chemical and biologic studies of the whole group of acid-fast bacilli, under the direction of the Research

Committee of the National Tuberculosis Association, are aiding in interpreting the mechanism underlying the varying pathology characteristic of tuberculosis.

The authors discuss especially the chemical partitions thus far studied, and the phosphatid fraction from the lipoids, as isolated by Dr. R. J. Anderson of Yale University. Comparable phosphatid fractions from human, bovine, and avian tubercle bacilli have been isolated. In a study of 350 clinical cases during the past two years, of which the majority were tuberculous, frequent ability to precipitate the tuberculo-phosphatid in high titer, or the precipitation with a phosphatid antiserum of suspected uncombined antigen, has been demonstrated. Twenty-six of thirty-two cases of Hodgkin's disease showed a capacity of the blood serum to precipitate the phosphatid in a dilution of 1-640 (of an original 1 per cent suspension) or higher. This is well within the range of positive reactions observed in known tuberculous cases. An ultimate understanding of both the pathological agent or factor and the mechanism of adjustment or resistance must precede any final approach toward the control of each definite etiological entity in disease.

F. B. MANDEVILLE, M.D.

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The Genetic Neoplastic Relationships of Hodgkin's Disease, Aleukemic and Leukemic Lymphoblastoma, and Mycosis Fungoides. Aldred S. Warthin. *Ann. Surg.*, January, 1931, XCIII, 153.

In 100,000 diagnostic tissue examinations made in the Pathological Laboratory of the University of Michigan between the years 1895 and 1927, there were 506 cases, approximately 0.5+ per cent, of all cases diagnosed as Hodgkin's disease, aleukemic and leukemic lymphoblastoma, and mycosis fungoides. During the same period, in 2,000 autopsies, there were 83 cases falling into the same diagnostic categories.

An analysis of the above material forms the foundation upon which the following conclusions are drawn:

1. Hodgkin's disease, sarcomatous Hodgkin's, aleukemic and leukemic lymphoblasto-

ma, aleukemic and leukemic mycosis fungoides are all true neoplasms and are genetically closely related.

2. Transition forms between all of the types exist.

3. They differ chiefly in the degree of differentiation shown by their cell types, and in their point of origin.

4. They all take their origin from perivascular reticulo-endothelium, or the maternal lymphoblasts of the lymphoid tissues of the body.

5. Those arising from the hematopoietic perivascular reticulo-endothelium take on the type of Hodgkin's, sarcomatous Hodgkin's (reticulocytoblastoma), or even of myeloid forms of sarcoma. Those arising from the maternal lymphoblasts have the character of the lymphoblastoma, small-celled or large-celled, aleukemic or leukemic. The maternal lymphoblasts are derived from the same perivascular reticulo-endothelium, but represent a higher stage of differentiation than do the Hodgkin's and the reticulocytoblastoma forms. The sarcomatous Hodgkin's of the reticulocytoblastoma type represents a greater differentiation than the Hodgkin's type, while the lymphoblastoma represents a higher stage of differentiation.

The more undifferentiated forms, Hodgkin's, sarcomatous Hodgkin's, and typical lymphoblastoma, occur chiefly in individuals of younger ages, while the typical aleukemic and leukemic neoplasms are more frequent in older individuals.

7. They all run a similar clinical course, often with fever, characterized by remissions and recurrence of the tumors, with the development of a progressive tumor cachexia, anemia, emaciation, and prostration. No case has ever been cured; when removed surgically, the regenerated glands become similarly involved in the process. While suggesting analogies with chronic infectious processes, they differ from these in that no mild or cured cases occur, there is no evidence of any immune reaction on the part of the organism, and the process shows a steady malignant progression to the fatal termination.

8. Pathologically, the lesions are neoplastic in type rather than granulomatous: they show

true infiltrations and metastases. In their cell types and architecture they follow definite patterns which cannot be explained on the basis of an inflammatory reaction.

9. There is but one method of treatment which will delay but will not halt the inevitable malignant progress of these growths, and that is the judicious and systematic employment of X-ray irradiation.

F. B. MANDEVILLE, M.D.

Bone Changes in Hodgkin's Disease. Kurt Kremser. *Röntgenpraxis*, Nov. 1, 1930, II, 998.

Lymphogranulomatous involvement of the medulla of bones has been described rather infrequently. Changes in the compacta and spongiosa are not so frequent. In fifty-one cases this occurrence was found only twice. The changes in the roentgenogram are destructive in character, proliferative changes not having been observed. The vertebrae seem to be attacked more often than other bones, and only in the later stages of the disease does bone involvement seem to take place, which cannot be differentiated from other metastases in the roentgenogram. It was interesting that, contrary to other metastases, roentgen therapy did not seem to have any effect on the lesions.

H. W. HEFKE, M.D.

## JAUNDICE

The Clinical Significance of Jaundice. M. A. Blankenhorn. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1066.

Although the physiologist and the pathologist have in recent times thrown great light on the problem of the formation of bile pigment and on certain functions of the liver, little has developed to help the surgeon with his question about stoppage of the ducts. The first and most important significance of jaundice is the possibility of stoppage of the ducts. To make a diagnosis of obstructive jaundice, one of three common procedures is generally followed: (1) If there is a history of colic, one argues from cause to effect, and says that

the stone that causes colic obstructs the duct; (2) tests for liver disease or tests of liver function can be done to exclude obstruction of the duct; (3) the symptom of jaundice can be studied to see whether obstruction of the ducts alone could give such a distribution of bile pigment.

Schiff reported no exception among 327 normal persons and patients that the van den Bergh direct reaction occurs with jaundice and bilirubinuria, and that the indirect reaction occurs with jaundice with no bilirubinuria, regardless of the pathogenesis of the jaundice. The study of the distribution of bile pigment to see whether stoppage of the ducts alone could explain the jaundice requires relatively simple laboratory methods.

The icteric index and the examination of duodenal contents and of the feces are simple and of good repute when properly interpreted. Cholecystograms by the Graham method unfortunately cannot be used when jaundice has fully developed. No other dye tests can apparently be used when jaundice is present.

CHARLES G. SUTHERLAND, M.D.

**Physiologic Disturbances Incident to Obstructive Jaundice: A Review.** A. C. Ivy. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1068.

The physiologic disturbances incident to obstructive jaundice are too numerous to list and to discuss even briefly in a short review. Bile retained in the biliary passages not only may pass into the blood and thus influence many organs, but also may disturb the functions of the liver and the gastro-intestinal tract. Even if bile were not toxic in itself, one would expect disturbances due (a) to the effect of excessive biliary pressure in liver function; (b) to reflexes excited by excessive biliary pressure; (c) to the absence of bile in the intestine, and (d) to the effects secondary to these changes.

The toxicity of bile is discussed, also the liver damage, lack of bile in the intestine, and terminal nephritis. The patient suffering from prolonged jaundice presents a picture that results from the failure of a number of physiologic mechanisms. It is not known

which one is primarily concerned. The fundamental nature of the reactions involved in producing the physiologic disturbances is not completely understood at present. The literature indicates that a carbohydrate diet, with milk and cod liver oil and calcium administration, is a worth-while therapeutic procedure in this condition.

The problem is being actively attacked by several groups of investigators, and the future of the understanding of physiologic disturbances in jaundice augurs well.

CHARLES G. SUTHERLAND, M.D.

### MEASUREMENT OF RADIATION

**Concerning a Source of Error in Calibrating a Müller Low Voltage Tube.** Lothar Böhmer. *Strahlentherapie*, 1930, XXXVIII, 353.

Ionization measurements on low voltage X-ray tubes by interposing diaphragms of different diameters (5, 10, 15, and 20 mm.) revealed the fact that the strength of the beam without a diaphragm was 34 per cent higher than with the largest diaphragm. This may lead to errors in dosage if the calibration has been carried out with a diaphragm while the patient is treated without using one.

ERNST A. POHLE, M.D., Ph.D.

**Measurements of the Half Value Layer in Aluminum.** Heinz-Theodor Meyer. *Strahlentherapie*, 1930, XXXVIII, 329.

The absorption curves for roentgen rays produced at potentials between 30 K.V. and 190 K.V. at 10 K.V., steps were measured in aluminum by means of a large and a pressure ionization chamber. A therapy tube connected to a constant potential apparatus was used. From the absorption curves, the normal and reduced half value layer were obtained. The latter is procured by substituting the radiation used at any given point by its equivalent homogeneous radiation. Curves were then plotted, expressing the quotient obtained by dividing the normal and reduced half value layers. They show a striking irregularity between 90 K.V. and 110 K.V., which is in all

probability due to the influence of the K radiation of the tungsten anticathode.

ERNST A. POHLE, M.D., Ph.D.

**Meteorological-medical Radiation Measurements in Defined Regions of the Spectrum.** K. Büttner. *Strahlentherapie*, 1931, XXXIX, 358.

Based on investigations of Dorno, the author constructed an apparatus consisting of photo-electric cells, actinometer, and filter, which permits measurements in various parts of the spectrum of importance to the meteorologist and physiologist. A number of measuring results in the spectrum of the sun are reported.

ERNST A. POHLE, M.D., Ph.D.

### RADIATION SICKNESS

**The Relation between Cholesterol Metabolism and Roentgen Sickness.** Rudolf Hummel. *Strahlentherapie*, 1930, XXXVIII, 308.

The cholesterol content of the serum is usually lower in man following roentgen deep therapy. In a few cases, the cholesterol is increased about three hours after the exposure. No relation between cholesterol drop in the serum and roentgen sickness could be observed, while the cholesterol drop in the total blood and roentgen sickness seemed to run parallel. The prophylaxis and treatment of roentgen sickness with "Colsil tablets" containing cholesterol, as suggested by Burgheim, were successful only in about 25 per cent of all cases.

ERNST A. POHLE, M.D., Ph.D.

**Immunological and Biochemical Researches on the Biological Action of X-radiation and Radium.** Luigi Cappelli. *La Radiologia Medica*, August, 1930, XVII, 905.

The theory that roentgen sickness is due to the formation of foreign proteins in the body which would cause a defensive reaction in the organism has been the object of study on the

part of the author. He has resorted to immunological methods to attain a greater sensitivity than that obtained with chemical investigation.

The serum of three rabbits which had been given slightly different quantities of X-radiation was tested with the serum obtained from another rabbit heavily irradiated (950 r).

The serum of the latter was taken some hours after treatment; that is, when the general effects of radiation are felt most. The ratios in X-ray dosages were approximately the same as the ratios of the quantities of the substances used in immunological tests. According to the author, the mildly irradiated animal would have supplied the antibody, while the other would have furnished the antigen. No flocculation was observed, however, and the author voices the belief that the cause of roentgen sickness must be found elsewhere.

L. MARINELLI.

### RADIUM

**Post-operative Parotiditis: Treatment without and with Radium.** Fred W. Rankin and Bean M. Palmer. *Ann. Surg.*, December, 1930, XCII, 1007.

In the last four years, there have been 78 cases of post-operative parotiditis at the Mayo Clinic. The condition occurs most frequently following operations on the gastro-intestinal tract, more especially the sigmoid and rectum. Of the 58 cases treated without radium, 23 died—a mortality of 39 per cent. Of the 20 cases treated with radium, four died—a mortality of 20 per cent. Three of the four cases died of causes definitely other than parotiditis, so that the corrected total for radium cases reads 5 per cent. In only two of the 20 cases was it necessary to substitute surgical drainage.

By using radium, particularly by immediate application, within from one to two hours following swelling, the incidence of suppuration and absorption is decreased noticeably, with resulting decrease in morbidity and mortality. The maximal dose consisted of four applications, eight hours in duration, at intervals of eight hours, and of four 50-mg. tubes of ra-

dium. Filtration was through 2 mm. of lead, 1 mm. of brass, and 0.5 mm. of silver; the distance was 2.5 cm., and a total of 6,605 mg.-hrs. was given. The minimal dose was two applications, eight hours in duration, at intervals of eight hours, and of two 50-mg. tubes of radium, with filtration as above, and a total dosage of 800 milligram-hours.

F. B. MANDEVILLE, M.D.

**Gynecological Notes, with a Special Reference to the Use of Radium.** Kenneth Wilson. *Med. Jour. Australia*, Dec. 13, 1930, II, 786.

This is a summary and descriptive review of the Heyman, Lacassagne, and Donaldson technic in the treatment of carcinoma of the cervix, with descriptions of the current Continental practice in the use of radium in other gynecologic conditions. Although a purely *réchauffé* dish compounded from existing literature and a visit to European clinics, the paper has value in presenting the prevailing radium practice in a general non-critical manner.

J. G. STEPHENS, M.B. (Syd.), D.M.R.E.

**Cosmetic Results of Electrocoagulation and Radium Treatment, Especially of Carcinoma of the Skin.** A. Buschke and Ludwig Loewenstein. *Med. Klinik*, Oct. 24, 1930, XXVI, 1590.

Electrocoagulation is used only in combination with irradiation therapy in the authors' clinic. The first treatment and its correct administration is most important for the prognosis. Electrocoagulation should be preferred to surgery, as the danger of recurrences and implantation of metastases is much smaller. The tumor thus treated is covered with boric acid ointment for from eight to fourteen days, and radium treatment is instituted at that time. Fractional doses are used, and the lesion usually is healed in from three to eight weeks, depending upon its size. Local recurrences after this combination treatment are not frequent—much less, in fact, than after surgical excision. The cosmetic results are very satisfactory. Benign tumors, such as

warts, pigmented moles, angiomas, and rhinophymas, have been treated by electrocoagulation with good results.

H. W. HEFKE, M.D.

**Radium Treatment of Early Epithelioma of the Lip.** Howard Hailey. *Southern Med. Jour.*, December, 1930, XXIII, 1121.

The author states as follows: "I do not believe it is practical to outline a treatment for epithelioma of the lip which will be suitable for all cases." He then discusses the several methods advocated for malignant lesions on the lip, and states his belief, based on personal experience, that radium, properly used, will give a higher percentage of permanent cures of early squamous epithelioma of the lip than any other single method of treatment. His technic is to transfix the lip with several five-milligram needles of radium, just distal to the growth, leaving them in place for seven hours. Radium is also placed on the surface of the lesion.

(*Abstractor's note:* This author does not mention the treatment of the gland areas with X-ray, although he uses a half-strength plaque over the submental area, with 0.5 mm. brass filter, 10 to 12 hours. This appears to me to be a totally inadequate radiation for the lymphatic areas in treating cancer of the lip.)

W. W. WATKINS, M.D.

**The Detection, Estimation, and Elimination of Radium in Living Persons Given Radium Chloride Internally (II).** Howard H. Barker and Herman Schlundt. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 418.

Elimination of radium chloride or other radium salt after introduction into the body by oral, intramuscular, or intravenous routes, has received particular investigation since the so-called "radium poisoning" cases gained public attention. Previous investigators computed elimination by collecting feces and urine, and estimating, quantitatively, the amount of radium excreted daily. From 25 to 35 per cent of that taken by mouth and from 55 to 65 per cent of that given intra-



venously is excreted within from four to five days of administration, but thereafter the rate of elimination in each instance is less than 1 per cent daily.

The present investigation was carried out on 10 patients ranging in age from 30 to 75 years, all of whom had taken radium amounting, in one instance, to as much as 1,130 micrograms of radium chloride, for a varied group of ailments, none of which had responded well to the usual therapeutic measures. The penetrating radiation within the body was tested for by a Wulf-Hess quartz fiber electroscope, while two new Lind ionization chambers, with an electroscope head, were used for detection and estimation of radium in the expired air of the patients, all radium values being expressed in terms of micrograms. Four of the 10 individuals were negative so far as radio-active tests were concerned, and the fifth case showed a mere trace. In three of the five remaining cases the patients had received material so recently that the finding of radio-active materials in their bodies caused no surprise. The two cases showing the largest amounts of radio-active material in their systems had had no radium administration for a period of two years, but each of these had had large amounts (one 890 and the other 1,130 micrograms) for intractable venereal disease.

J. E. HABBE, M.D.

**Hairy Tongue Following Adjacent Radiation.** M. T. Van Studdiford. *Southern Med. Jour.*, December, 1930, XXIII, 1125.

Eight patients with carcinoma of the upper digestive tract (tonsil, tongue, mandible) developed hairy, or black tongue, within from two to five weeks following adjacent radium treatment. The whole lingual mucosa was involved in two cases, the condition persisting for eighteen months. Whether this was due to a symptom-complex inducing hyperplasia of the papillae and pigmentation as the result of the organism found by Weidman (*Archives of Dermatology and Syphilology*, November, 1928, XVIII, 647), or to a stimulation by the irritant effect of radium, or to a lowering of the resistance of the mucosa, allowing

invasion by organisms, has not been determined. The diseased area has a black-brown or yellow-brown fur-like appearance, made up of hairs measuring from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in length.

W. W. WATKINS, M.D.

**The Present Status of Radium Surgery.** H.-G. Zwerg. *Strahlentherapie*, 1930, XXXVIII, 487.

This is a review of the combined surgical and radium treatment of malignant tumors in the paranasal sinuses, larynx, esophagus, bladder, prostate, rectum, and stomach. Although Regaud does not believe in the value of radium surgery in uterine carcinoma, because of the high development of roentgen therapy, the author feels that the former is of benefit in the treatment of involved lymph glands and parametrium.

ERNST A. POHLE, M.D., Ph.D.

**Radium and its Use in Uterine Diseases.** W. E. Gary. *Kentucky Med. Jour.*, September, 1930, XXVIII, 454.

There is no known method of determining which case will and which case will not respond to radium, without trial, any more than which will or will not be benefited by surgery or other means. Radium and X-rays give off the same rays, but radium can be placed where needed and the selected wave be had by proper screening. The uterus can stand more radiation than any other organ in the body, and radium is the accepted treatment in all cancers of the cervix. If competent surgeons and competent radiologists will co-operate, the future will be bright for increase in the number of cures in malignant disease, especially if the general practitioner will help by sending cases early.

W. W. WATKINS, M.D.

**Radium Therapy in Cancer of the Nose, Larynx, and Esophagus.** H. M. Moran. *Med. Jour. Australia*, Dec. 20, 1930, II, 814.

Obstruction is frequently the primary symptom of tumors of the nasopharynx, by which time it is impossible accurately to gauge the

degree of bone or cartilage involvement. Interference with sinus drainage brings infection in its train. With bone invasion, osteomyelitis occurs; with cartilage invasion, necrosis occurs, and the sinister conspiracy of neoplasm, infection, and necrosis compasses the patient's destruction.

*Cancer of the Maxilla.*—In neoplasms of the superior maxilla the surgical act should be exploited to the utmost and the subsequent irradiation should be as complete as if no surgical treatment had been given. Cylindrical-celled carcinomas predominate; squamous-celled carcinomas may arise by invasion from without or by metaplasia of primary cylindrical-celled growths. Myxosarcomas and angiosarcomas are found. Osteogenic sarcoma is rare. Lymphosarcomas may occur and permit of dramatic, if ephemeral, success. Treatment is best commenced with deep X-radiation. Two weeks later operation follows, and this should expose the growth and, if possible, completely remove it, but even incomplete extirpation is valuable. The preliminary X-radiation prevents scattering of cancer cells, which might be caused by an incomplete operation. Partial removal, although not accelerating the growth according to Ledoux, may yet cause dangerous bleeding and delay the third stage of radium treatment. Radium is next applied either in radon seeds or in tubes. The former gives a fading dose, and adequate filtration cannot be obtained without rendering the seeds bulky. Filtration by 2 mm. of platinum and a secondary filter of Al and rubber is essential. Three tubes each of 10 mg. introduced for eight days for small areas (from 30 to 40 mc. destroyed), or otherwise from 10 to 12 tubes each of 3 mg. for four days (from 25 to 30 mc. destroyed), are employed. These three stages should be completed within one month, and the associated lymphatic glands must then be considered. Ledoux strongly advises irradiation of first relay of lymphatic glands. Close surveillance of these areas is imperative.

*Cancer of the Nasopharynx.*—Fibrosarcoma is more radiosensitive the younger the patient, and in adult growths of this kind surgery is indicated. Lymphosarcomata are best treated

by X-radiation, and this type of growth is probably unique in the respect that irradiation of the primary focus has been known to cause the disappearance of distant metastases. The author commends the search for the cause of this phenomenon, which would reveal new horizons in radiotherapy.

*Laryngeal Cancer.*—In extrinsic growths the tumor is generally inaccessible and radio-resistant, and gland involvement is early, so that palliation only, either by radium used at a distance of several centimeters, or by deep X-rays alone, is possible. The uniform and efficient irradiation of the whole area with radon seeds is usually impossible and the radium bomb has not improved the depressing results. Intrinsic cancer is more hopeful. This is essentially a cancer of the vocal cord, becomes subglottic by extension, but is not by nature highly invasive. It is relatively avascular, remains for a long time unilateral, and gland involvement is usually late. Moreover, an early alteration in voice quality acclaims the onset, and causes the patient to present himself at an early stage in the disease. Surgery gives good results in intrinsic cancer, and radium may give superior functional results, with a better voice quality. For effective radium treatment, the growth must be confined to the chord, and neither anterior commissure nor muscle nor cartilage be invaded. Voice quality is, of course, less important than final cure, and the choice between surgery and radium is as yet undecided.

The greater part of the lateral cartilage is resected, but it is essential that the perichondrium on the inner side should be left intact to shield the larynx from secondary inflammation. From 5 to 10 needles of one-half or one mg. of filtration, 0.5 mm. platinum, and length of from one to two centimeters, are placed vertically in the window thus made, and their tips tucked behind the cartilage, without perforation of the larynx. The threads of the needles are steeped in one in a thousand acriflavine solution. The wound is closed without drainage and the needles left in for from four and a half to eight days. Within ten days the tumor is reduced to a mere nodule, and usually disappears within six weeks. This technic, the only needle technic justifiable

in the larynx, is, of course, suitable only for growths of limited extent on account of the greater distance of the posterior needles from the growth. The author is emphatic in warning against the embedding of needles within the larynx. Glottis edema, following treatment, may necessitate low tracheotomy. Necrosis of cartilage, after deep X-radiation, at any rate, is an exaggerated danger unless the cartilage has become ossified, in which case the secondary rays may produce the condition. If the tumor has become subglottic a preliminary and very thorough distance radiation is advisable, after which the hemilaryngectomy is performed, and the same radium dose given as before. The vegetative or ulcerative type of growth arising in the ventricular cavity or band resembles the mucous membrane type of epithelioma, and is radiosensitive and suitable for deep X-ray treatment.

*Cancer of the Esophagus.*—The author doubts whether or not esophageal cancer is ever cured by our present methods. Inaccessibility, late appearance of symptoms, extensive longitudinal lymphatic spread, and early onset of infection account for the poor results. Fusion of enlarged posterior mediastinal glands may deflect the esophagus, as shown radiographically. The futility of introducing tubes of radium within the structure is thus manifest. Gastrostomy, to place the diseased area at rest, and to provide nutrition, should be the first step. Irrigation with a 2 per cent sodium bicarbonate may reduce the infection. The lesion is outlined accurately, either by radiography or by esophagoscopy. The treatment then proceeds, according to Guisez's or de Nabias' technic. The characteristic unpleasant salivation is usually not relieved, although the production of saliva can be controlled radiologically.

J. G. STEPHENS, M.B. (Syd.), D.M.R.E.

**Radium in Superficial Face Lesions.** W. A. Chernosky. *Texas St. Jour. Med.*, December, 1930, XXVI, 573.

The application of radium to superficial lesions of the face is usually a simple procedure, though sometimes tedious when cosmetic results are borne in mind. The operator's skill

may be taxed to destroy a large growth without unnecessary injury to surrounding healthy tissue. In early lesions radium gives good results, with minimum scarring. The use of radium, being harmless and painless, encourages patients to apply early for treatment. If the radium treatment is not successful, surgical measures may be resorted to without detriment to the patient. By combining the two methods, or using radium post-operatively, the percentage of permanent cures may be increased.

W. W. WATKINS, M.D.

**Contribution to the Radium Therapy of the Bleeding Nipple.** Fritz F. Dautwitz. *Strahlentherapie*, 1930, XXXVIII, 710.

The history of two women is related, who were treated with gamma rays of radium 12 and 17 years ago for bleeding nipple. The total doses applied amounted to 20,729 mg.-hrs., given during a period of five years, and 26,950 mg.-hrs. given during three and one-half years. Both patients are still well to-day. In doubtful cases and those in which operation is refused, the author suggests that radium therapy should be given a trial.

ERNST A. POHLE, M.D., Ph.D.

## ROENTGENOTHERAPY

**A Note on the Treatment of Erysipelas by X-rays, with an Account of Three Cases.** R. Hillhouse Jamieson and F. Hernaman-Johnson. *British Med. Jour.*, Jan. 10, 1931, No. 3653, p. 57.

The value of X-ray therapy as an agent capable of cutting short the acute stage of erysipelas, was first advocated by Platau, Schlitz, and Collins. In the present account, the course of the disease in a case treated in the usual way by local applications and serum, is contrasted with two cases treated by the X-ray. In the first case the temperature fell by lysis, and in those treated by the X-ray by crisis, and the improvement in both the local and general condition was dramatic. How these very small doses accomplish their purpose is uncertain, but it would seem to be due to a stimulation of the local and general

resistance. It is not due to any direct destruction of germs.

It is concluded that, as regards erysipelas, the authors have in the X-ray a powerful weapon which can be confidently recommended in any case which causes anxiety to the doctor or the patient.

WALLACE D. MACKENZIE, M.D.

**On the Question of the Distribution of Roentgen-ray Intensity in the Human Body in Deep Therapy. I.—Critical Review of the Problem and its Principles.** M. Dornreich. *Strahlentherapie*, 1930, XXXVIII, 591.

This is the first of a series of articles dealing with the problem of isodose curves. The literature of the past, concerning the subject, is analyzed and the fundamental principles of the measuring methods are discussed.

ERNST A. POHLE, M.D., Ph.D.

**The Roentgen Treatment of Metastasis to the Vertebrae and the Bones of the Pelvis from Carcinoma of the Breast.** Eugene T. Leddy. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 657.

The author maintains the fact that carcinoma of the breast may metastasize early is not taken seriously enough in clinical practice, for the spine or pelvis may be the seat of trouble for a long time, without other lesions and without symptoms or apparent change in the patient's condition. Hence, the high incidence of skeletal metastasis makes it an important problem for the pathologist, the internist, and the radiologist. The author believes that metastasis from carcinoma of the breast reaches the pelvic and vertebral bones, probably by a combination of aberrant and reflux spreads through the lymphatics, and is often accompanied by an inflammatory reaction of non-infectious origin, the most common symptom being pain in the right sciatic nerve. Treatment by roentgen rays by an effect on both the inflammatory and malignant cells in the metastatic growths, produces analgesia, often complete and of months' duration, and is the best method of palliating

the hopeless disease. Several tabulations are included in this paper.

J. E. HABBE, M.D.

**A Simple Field Selector in Roentgen Deep Therapy.** Georg Heinrich Schneider. *Strahlentherapie*, 1930, XXXVIII, 762.

This is a description of a simple arrangement which facilitates the selection of fields in roentgen therapy. Its principles consist of a frosted glass plate bearing a co-ordinate system in centimeters. The anatomical cross-sections and isodose curves can be placed under the plate.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Therapy of the Spine in Skin Diseases.** A. Krynski. *Strahlentherapie*, 1930, XXXVIII, 730.

Gouin has recommended superficial roentgen therapy directed to the spinal region in order to influence certain skin diseases. He uses roentgen rays of little penetration because he wishes to affect only the superficial nerves and not the deeper lying spinal cord. The author employs a modified technic: 150 K.V., 3 mm. Al, 4 H per field (approximately 350 r), 30 cm. F.S.D. Each field is 10 cm. long; the upper area is centered over Th. 2-3, the lower area over Th. 12. Treatments are given at three weeks' intervals. If after three exposures there is no response, an interval of from 6 to 9 weeks is advisable. In conclusion, the author states that this treatment is the method of choice in cases of lichen ruber planus. He also cured two severe cases of dermatitis herpetiformis. Definite improvement was seen in patients with neurodermatitis, eczema, and pruritus. The only reaction following the treatment consisted in sweating and slight nausea on the following day.

ERNST A. POHLE, M.D., Ph.D.

**Radiation Therapy of Thrombophlebitis.** Josef Halban. *Wien. klin. Wchnschr.*, Nov. 6, 1930, XLIII, 1368.

The roentgen treatment of inflammatory diseases has been established since Heidenhain and Fried published their results. The author

used the following treatment in seventeen cases of thrombophlebitis: 180 K.V., 3 ma., a filter of 0.5 mm. Zn and 2 mm. Al, and a distance of 28 centimeters. About 15 per cent of a skin erythema dose was given, and several fields were used when the phlebitis extended over considerable length. The results were very gratifying. The pain, which is often very severe, disappeared shortly after the treatment, the swelling receded rapidly, and the recovery of the patient was hastened. The results were so good that all such cases were submitted to roentgen treatment. One must be very careful in moving a patient and should, if possible, transport him only in his own bed, as lung emboli are always to be feared.

H. W. HEFKE, M.D.

**Relative Value of Roentgen and Radium Therapy.** R. H. Crockett. *Texas St. Jour. Med.*, December, 1930, XXVI, 578.

Two very elementary but important questions are often asked by referring physicians and patients, *viz.*: "Just what good will X-ray or radium treatment do?" "Which is the better, X-ray or radium treatment?" Without a categorical answer to these questions, the author discusses many conditions in which radium or the X-ray may be used and his usual practice in choosing the type of radiation. The discussion covers fibroids of the uterus, malignancy of the breast (in which he advocates pre-operative and post-operative radiation, the latter including three cycles of treatment), and malignant conditions in general.

W. W. WATKINS, M.D.

**Deep Roentgen-ray Therapy of Mammary Carcinoma. II.—Five-year Results: Value of the Method as an Auxiliary to Surgical Procedures in the Operable, and as a Primary Procedure in the Inoperable Cases.** William A. Evans and T. Leucutia. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 673.

In 1925, the authors presented their first experiences with deep roentgen therapy in

carcinoma of the breast, giving, in detail, their method of procedure and the technic of irradiation in both the operable and inoperable cases. Analysis showed that roentgen therapy in its new, short wave length application forms one of the most powerful agents in the treatment of mammary carcinoma. In this present article a detailed statistical account is submitted of the five-year results obtained in the previous series. These statistical results are presented in the form of tabulations, there being thirteen.

The authors conclude that roentgen therapy in its short wave length application is of considerable aid in the treatment of operable mammary carcinoma as an auxiliary to surgical procedures. In the cases without glandular involvement, the addition of irradiation does not noticeably increase the five-year results above those of surgery alone. However, in the cases in which the carcinoma has already spread to the axillary or the high thoracic lymph nodes, the five-year results are nearly doubled. The best method of procedure is considered to be a combination of radical surgery, with a systematic irradiation of the entire anterior thorax, axilla, and neck on the diseased side. In the inoperable or recurrent mammary cases, roentgen therapy produces prolongation of life and alleviates the symptoms.

J. E. HABBE, M.D.

**Our Experience with the Protracted Fractional Roentgen Treatment of Coutard.** A. Kahlstorf and A. Zuppinger. *Strahlentherapie*, 1930, XXXVIII, 199.

Since April, 1929, the authors have treated 52 cases of far advanced malignancies with the method of Coutard. A potential of 170 K.V., filter of 0.45 mm. chrome iron, plus 1.0 mm. copper, plus 1.0 mm. aluminum, giving a half value layer in copper of 1.113 mm., were used. The F.S.D. varied from 60 to 100 cm., while the single dose amounted to about 150 r; treatments were given daily over a period of from three to four weeks. The total doses applied were between 4,800 and 7,200 r, as measured in air.

All cases are discussed in detail, giving the essential parts of the history and the outcome.

Many photographs of patients accompany the article. In spite of the fact that the authors were dealing with advanced cases, they were able to obtain temporary cures in nine cases. The reactions of the skin and of the mucosa following this type of treatment are entirely different from those customarily observed after single heavy doses. These reactions are described in detail and a number of photomicrograms show the histological characteristics. Since this method employs such high total doses, a very careful observation of the reactions is essential in order to prevent acute or latent injuries. In many cases, the regression of the tumors started several days after the beginning of the treatment. Cases with a recurrence did not respond to additional treatment, as a rule. In such patients, it is better, provided the procedure can be carried out, to remove the remaining tumor by electrocoagulation. When treating tumors within the mouth, great caution must be used in order to prevent bone necrosis. The removal of teeth after the treatment is not advisable. Although it is impossible to report end-results obtained with this treatment method, the authors feel that it should be studied further in inoperable cases of neoplasms.

ERNST A. POHLE, M.D., Ph.D.

**Radiation Therapy of Polycythemia Vera.** George T. Pack and Lloyd F. Craver. *Am. Jour. Med. Sci.*, November, 1930, CLXXX, 609.

Polycythemia may be functional (altitude, fright, dehydration, etc.) or essential (polycythemia vera). Polycythemia with splenomegaly is the common type, and, in this, irradiation is the treatment *par excellence*. The disease is due to overproduction of the red cells by the bone marrow, and failure of the cell-destroying mechanism of the body to keep pace with production. Polycythemia is a clinical analogue of myelogenous leukemia, and treatment should be directed to the radiosensitive marrow cells. Splenectomy is contraindicated, and radiation is superior to chemical agents. Since the locus of the disease is in the bone marrow, sufficient irradiation should be given to inhibit or depress but not

to destroy erythropoiesis. The dosage must be exact, and will depend on the severity of the illness. The treatment must be carefully controlled by observing the condition of the patient and the number of leukocytes. Both long and short bones may be treated, but particularly the long bones; the head and the pelvis should not be treated, to avoid alopecia and effect on the gonads. The irradiation prevents the formation of new erythrocytes, and is not designed to destroy red cells already formed. The suggestion has been made that stimulative doses should be applied to the spleen to increase cell destruction, but these authors question the value of this. Some interesting case reports are given in detail.

W. W. WATKINS, M.D.

**The Effect of Roentgen Rays on the Eye.** W. Rohrschneider. *Strahlentherapie*, 1930, XXXVIII, 665.

The author, who has done a considerable amount of experimental work of his own concerning the effect of radiation on the eye, discusses critically the literature on the subject. He summarizes our knowledge in a tabulation which gives the tolerance and injurious doses for the various parts of the eye, as compared with the epilation dose. It appears that the lens is most sensitive, since an epilation dose represents its tolerance. Conjunctiva and cornea tolerate from 20 to 30 per cent more than the so-called erythema dose. The margin of safety is greater for heavily filtered radiation. In conclusion, the author emphasizes that he does not wish to discourage the use of roentgen rays or radium in diseases of the eye, but merely wishes to draw attention to the fact that caution is necessary in prescribing radiation therapy in ophthalmology.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Treatment of Hyperthyroidism.** Wright Clarkson. *Virginia Med. Monthly*, November, 1930, LVII, 498.

The mortality in surgical treatment of hyperthyroidism has been reduced to 1 per cent in the hands of the best surgeons, but a method which will give as good results as surgery

should be welcome. Reports in medical literature indicate that irradiation is a worthy rival of surgery in treating hyperthyroidism. The very conservative report of Groover, Christie, Merritt, Coe, and McPeak on 305 patients showed more than 88 per cent cured, and only 2.5 per cent unimproved. The author's technic is high voltage, heavy filter, and short exposures at intervals of from ten days to three weeks. Care should be taken to include the thymus in the radiation. The general care of the patient is important, with bed rest for acutely ill patients, removal of foci of infection, and the treatments controlled by frequent basal metabolic tests.

W. W. WATKINS, M.D.

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**Roentgen Therapy of Tabes.** Curt Kremsler. *Strahlentherapie*, 1930, XXXVIII, 719.

Forty-four patients suffering from tabes were treated by roentgen rays. The technic is as follows: 180 K.V., 4 ma., 0.5 mm. Cu, 23 or 30 cm. F.S.D., one-third E.D. per field. In the first group, two lateral fields and one posterior field over the spine were given. The total dose in the cord amounted to from 70 to 90 per cent E.D. In the second group, two oblique fields, one to the left and one to the right of the spine, were applied, one-third E.D. per area. The third group received one field directly over the spine, one-third E.D. per treatment. In the fourth group, the technic of the second and third groups were combined. In 11 cases there was no effect at all upon the symptoms, particularly the pain. Four patients were slightly improved, 20 showed a temporary improvement, and only 9 obtained improvement over a longer period. In the opinion of the author, roentgen therapy may, therefore, be used as a symptomatic agent in tabes, but apparently does not influence the pathological process.

ERNST A. POHLE, M.D., Ph.D.

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**The Effect of High Voltage Roentgen Radiation (200 K.V.) upon the Fertility and Motility of the Sperm of the Rabbit.** Sydney A. Asdell and Stafford L. Warren.

*Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 81.

Twenty-two full grown female rabbits were used in these experiments. It has been found that ovulation in rabbits occurs about ten hours after copulation. For fertility studies, does were allowed to copulate with vasectomized bucks. One hour later these does were artificially inseminated with irradiated or control spermatozoa. Sperm for artificial insemination and for motility experiments was obtained by sacrificing a doe which had just copulated with one or more vigorous normal bucks. The abdomen was opened, the semen obtained and immediately divided into two equal portions and placed in two thin petri dishes, one portion being given large amounts of radiation consisting of all the wave lengths in unfiltered or filtered beams of radiation produced at from 100 to 200 kilovolts. Motility studies of the sperm during these experiments gave no indication of any change resulting from the irradiation. Two litters of apparently normal young were obtained by artificial insemination with irradiated sperm.

J. E. HABBE, M.D.

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## SINUSES (DIAGNOSIS)

**Roentgen Examination of the Paranasal Sinuses and Mastoids.** Amédée Granger. *Jour. Am. Med. Assn.*, Nov. 1, 1930, XCV, 1332.

The author, from experimenting and after seven years' practical experience, is convinced that roentgenograms made in other positions do not show the same constant and clear anatomic boundary landmarks for the sphenoids, ethmoids, and paranasal sinuses, as those made by his method described in 1923. For the examination of the mastoid regions, roentgenograms were made in the position recommended by Law, and in the position described by the author in 1926. The Granger roentgenogram gave a more detailed view of the anatomy of the mastoid region and process, with fewer structures superimposed. It showed the different groups of cells, including the tip cells, much more distinctly; the superior semicircular and internal auditory canals;

the sharp outline of the mastoid cortex; and in this view the course of the external auditory canal is away from and does not overlie the shadow of the mastoid cells. Labyrinthitis has been diagnosed in several instances, to be confirmed by the usual otologic tests. A pre-operative diagnosis of tumor of the acoustic nerve was made in two cases. In infants and children under six years of age, the Law position is the only one that can be satisfactorily employed. The author summarizes his observations on an intensive study of roentgenograms of children presented in 1929.

C. G. SUTHERLAND, M.D.

**Osteoma of the Frontal Sinus.** R. O. Leavenworth. *Laryngoscope*, December, 1930, XL, 885.

The literature up to 1926 shows 117 reported cases of osteomas of the frontal sinus. The tumors are most often encapsulated with a pedicle, but a few are ordinary exostoses. Numerous cases are on record in which the pedicle has become detached, causing what is termed a "dead osteoma." Occasionally there is an associated mucocele, and frequently a complicating acute frontal sinusitis. Osteomas are essentially benign and usually slow-growing, although they may increase their rate of growth and develop in a matter of weeks more than they did in the several previous years. The serious aspects are produced by pressure and encroachment into the cranial cavity and the orbit, as well as the frequent complicating acute frontal sinusitis. The diagnosis is, of course, by the X-ray.

A case is reported, diagnosed by the X-ray, of the exostosis type. The patient was operated on for relief of the frontal sinusitis, but the osteoma was not disturbed. The author has followed the case for seven years, and the growth of the osteoma has been only one-fourth of an inch. The patient is now symptom-free and has been so since the operation for the acute frontal sinusitis. The author does not think the removal of osteomas is usually indicated, as it is difficult to make a couple removal because of frequent origin in the ethmoid cells, and there are many reported cases showing a recurrence with a faster

growth-rate after partial removal. There is further danger in operating because extensive exposure of the dura may be necessary. If there are very serious symptoms from pressure and extension of the growth, extirpation of the osteoma should be attempted, and the prognosis with present surgical methods is good.

H. RUDISILL, JR., M.D.

**Chronic Antrum Disease.** L. E. Patrick. *Northwest Med.*, July, 1930, XXIX, 307.

Antrum puncture with a trocar, and washing, is the least reliable procedure in making a diagnosis of chronic infection, unless a microscopic examination of the fluid is made. In acute infections it is quite valuable. In chronic disease, puncture, with cytological examination as described by Sewall, is of value. The roentgen ray is the most important single factor in determining the pathology present, but, taken alone, is often misleading. Lipiodol as a contrast medium has not been very successful in the author's hands.

W. W. WATKINS, M.D.

**The Interpretation of Sinus Roentgenograms.** G. W. Grier. *Am. Jour. Roentgenol. and Rad. Ther.*, July, 1930, XXIV, 21.

The author emphasizes the value of stereoscopic postero-anterior views taken at three angles and supplemented by supero-inferior, lateral, and Granger projections.

Sinus pathology being dependent upon variations in the normal transparency, these densities have been classified as local and general. Localized areas of density may be produced by osteoma, fibroma, polyp, mucocele or cyst, hyperplasia of lining mucous membrane, or malignant newgrowth. Osteomata and fibromata are not as a rule distinguishable. Polypi, mucocelles, and cysts are likewise difficult to differentiate, but here the rhinoscopic findings should assist. The fuzzy or clean-cut appearance of the inner margin of a thickened lining membrane may aid in determining active or la-



tent sinus disease. Post-operative cases, especially antra, often show residual opacities. The only roentgen sign strongly suggestive of malignancy is erosion of bone in the vicinity of the tumor. Generalized densities of one or more sinuses, if pronounced, are usually due to empyema, extensive polyposis, or newgrowth. In differentiating the first two conditions, if there is ethmoid involvement a widening of the ethmoid regions is suggestive of polyposis.

The author has very rarely been able to demonstrate fluid levels in any of the sinuses. Slight uniform densities of the sinuses are observed in congestion of mucous membrane, old thickening of membrane of slight degree, post-operative cases, suppurative sinusitis where the pus is well drained out, and chronic hyperplastic sinusitis. Differentiation in such cases is quite impossible by the X-ray alone, but usually may be accurately made if the history is correlated with the rhinoscopic and roentgenologic findings.

J. E. HABBE, M.D.

### SINUSES (THERAPY)

**The Diagnosis and Treatment of Inflammation of the Maxillary Antrum.** Perry G. Goldsmith. *Canadian Med. Assn. Jour.*, October, 1930, XXIII, 512.

In the great majority of instances the mucosal inflammation of the maxillary antrum is caused by acute rhinitis. It is also associated with external violence, operations, abscessed teeth, infection of ethmoids and frontals, septal deflection, and enlarged turbinates as causative factors.

The symptoms of acute antral inflammation are excessive purulent nasal discharge, pain in the face (increased on leaning forward), and some tenderness in the canine fossa. Additional diagnostic agents are transillumination and diagnostic puncture. The X-ray is not needed in the acute cases. The author places great reliance on transillumination. Puncture of the antrum is valuable in the acute cases,

but not so valuable in the chronic cases, where secretion does not always form the main pathologic process.

The treatment of the acute condition depends on its degree. In such cases irrigation should be employed until the secretion becomes more gelatinous, or changes into a lemon-colored mucoid mass. If, however, after some weeks, the nasal or post-nasal discharge still persists, improved facilities for drainage and ventilation should be secured. This is accomplished by enlarging the drainage opening, followed by continued irrigation, and the instillation of neo-silvol or zinc sulphate, or even by ionization, which may be helpful.

The symptoms of chronic antral inflammation consist of chronic discharge, which may be thin and scanty, and of varying degrees of nasal obstruction, due to enlargement of the turbinate mucosa. The patient has frequent head colds, and sneezes.

The pathologic process is of a deeper character than in the acute condition. The deeper structures of the antral mucous membrane are attacked. Cysts are more common. Irregular edematous masses and diffuse hypertrophies are frequent.

The diagnostic measures used in the chronic condition are much the same as in the acute, with the addition of the X-ray. The information required from the X-ray examination pertains more to the character of the mucous membrane. This information is obtained better if the antrum is injected with lipiodol and olive oil (1-3), or bismuth in paroline.

The treatment of the chronic condition consists in attention to the general health, such as change to a warmer climate, and the securing of better nasal ventilation and drainage. These measures may involve straightening of a deflected septum or removal of the anterior end of the middle turbinate. If this does not suffice, increased drainage may be secured by enlarging the exploratory opening and repeated irrigation. If irrigation and ventilation do not effect a cure, the infected antral mucous membrane should be removed entirely through an opening made under the lip through the canine fossa.

L. J. CARTER, M.D.

**The Rational Surgical Treatment of Chronic Antral Disease.** John G. Hunt. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 386.

Operations for chronic maxillary sinusitis are now almost as common as those for chronic tonsillitis, thanks to the simplification of the diagnosis by the radiologist. With the advent of iodized oil, preliminary to radiography of the antra, it is now possible to tell at a glance, not only if the sinus is diseased, but also to say with a considerable degree of accuracy the type and degree of pathological change present in the lining mucosa, whether fibrous, polypoid, or purulent. This point is illustrated by five excellent reproductions of radiographs. Chronic maxillary sinusitis plays a large part as a causative factor in "chronic catarrh," chronic eye, ear, and pulmonary conditions, chronic headache, neurasthenia, and arthritis.

The indications for treatment are determined by the type of pathology present. The three types of treatment employed are the intra-nasal, the naso-antral, and the extra-nasal methods.

The intra-nasal method is based on the nasal obstruction theory as the cause of maxillary sinusitis, but fails usually because it ignores the local focus in the antrum.

The naso-antral method has the largest following. It consists in making a drainage opening from the lowest part of the antrum into the nasal cavity. It is of value only when free pus is present, and then often fails. If polypi are present the use of this method is indefensible.

The advocates of the extra-nasal method regard nasal obstruction and high antrum opening as quite irrelevant factors. They feel that, provided the nasal or remote symptoms are such as to demand operative interference, and the X-ray shows considerable increase in the mucosal density, the rational procedure is the complete extirpation of the infected mucosa. To do this it is necessary to have access to all parts of the antral cavity. Adequate approach through the nose being impossible, the simple expedient

of temporarily elevating the buccal mucous membrane and removing enough of the external bony antral wall was adopted.

The modern surgeon does not do the radical operation of complete ablation of the antral cavity, as advised by Caldwell and Luc, the pioneers of this operation. Only sufficient bone is removed to permit the excision of all diseased tissues, and a flap of nasal mucosa is turned into the cavity to provide a nucleus for the subsequent epithelialization. This method gives gratifying clinical results. It should not be used during an acute exacerbation of the infection.

L. J. CARTER, M.D.

### SKIN (THERAPY)

**The Action of Roentgen and Ultra-violet Rays on the Reticulohistiocytic System of the Skin.** Pietro G. Castellino. *Archivio di Radiologia*, July-October, 1930, VI, 681.

The author irradiated the backs of rabbits, with single varying doses of roentgen and ultra-violet rays, injected a vital stain (trypan-blue), and examined specimens from the fields irradiated at varying intervals. He found, histologically, a difference in effect, due, probably, to the difference in quality (penetrability) of these two types of radiation and the doses used.

E. T. LEDDY, M.D.

**The Need of More Conservative Roentgen Dosage in Skin Disease.** W. F. Spiller. *Texas St. Jour. Med.*, December, 1930, XXVI, 582.

The author discusses some unfortunate results often seen following radiation of the skin, and believes the remedy is in the more careful and conservative use of the X-ray. In benign conditions, he follows the MacKee technic of fractional skin doses. In malignant skin lesions he is opposed to massive doses, and thinks it is better to give second doses than to over-treat. He thinks that an accurate diagnosis should precede the use of the X-ray, that

the least amount of X-ray necessary for a good result should be used, that if a case does not respond well to X-rays some other method should be substituted, and that it is better not to use X-rays at all than to produce a radiodermatitis.

W. W. WATKINS, M.D.

**Multiple X-ray Carcinomas Following Psoriasis: Case Report and Comment.** Herman Goodman and Charles W. Price. *Arch. Phys. Ther., X-ray, Radium.* May, 1930, XI, 209.

This is a case report in which an examination revealed typical psoriatic patches over the extensor surfaces of the extremities and on the back. In addition, there was a radiodermatitis of the psoriatic regions of the arms and legs (120 square inches of radiodermatitis). Pathologic study from a section of an ulcer of the dermatitis showed it to be prickle-cell epithelioma. The psoriatic lesions developed 28 years ago. Six years ago the lesions were cleared up by twelve X-ray exposures. Shortly, the lesions reappeared and the patient received further X-ray exposures every 7 to 14 days for over a year. The disease became worse and ulcerated six months ago.

Arthur Alexander reported 18 cases of carcinoma on the basis of pre-existing psoriasis, 11 as arsenical carcinomas, and 7 as pure psoriasis carcinoma. This would indicate a feature of unrest in a psoriatic skin. MacKee has said that if psoriasis does not clear up after three treatments of one-fourth skin unit per week, that some other treatment should be instituted. From the authors' preliminary work it seems that an over-radiated skin can be detected early by filtered ultra-violet light.

HERMAN GOODMAN, M.D.

## SKULL (DIAGNOSIS)

**The Technic of Encephalography.** Carl D. Camp and R. W. Waggoner. *Arch. Neurol. and Psychiat.,* January, 1931, XXV, 128.

The authors state that there are two profound objections to encephalography: First, the severe reaction which the patient experi-

ences during and after the injection of air; second, the danger of this procedure in cases with increased intracranial pressure. To overcome part of this unfavorable reaction which is dependent, to some extent, upon the amount the patient is moved, they describe a new chair which permits the patient to occupy the horizontal position during the puncture. The chair may also be so adjusted as to allow the patient to rest in the vertical position. It is described in detail, as is also a combination tube-stand and Bucky diaphragm.

C. G. DYKE, M.D.

**Calcification of the Cerebral Falx.** Giovanni Balestra. *Archivio di Radiologia,* July-October, 1930, VI, 731.

The author reports two cases showing, respectively, a large isolated area of ossification and multiple calcifications of the falx. He gives points of differentiation between the roentgenologic findings in ossification (osteomas) and granular calcification. He emphasizes the importance that granular calcifications have in regard to isolated osteomas, especially if they are not limited to the falx.

E. T. LEDDY, M.D.

**Intracranial Calcification, with Particular Reference to that Occurring in the Gliomas.** Cyril B. Courville and Leo J. Adelstein. *Arch. Surg.,* November, 1930, XXI, 801.

The literature in regard to intracranial calcification of various kinds is quite well covered, and it is shown that calcareous deposits may be found in practically every type of primary intracranial new growth, with the exception of the craniopharyngeal cysts. It is probably most common in the gliomas. This calcification is of considerable value in the roentgenographic examination of the skull, as the distribution of the calcareous material is usually evenly spread throughout the tumor tissue and gives some conception as to its size and relationship. There may be such a small amount of calcification present that it is not shown on the roentgenogram. Roentgen examination usually reveals an associated thinning of the skull over the tumor, indicating a

local, rather than a general, increase in pressure.

Twelve cases are reported. Of the ten growths verified histologically, five proved to be neuroglia-blastomas, three were astrocytomas, one was an ependymal glioma, and one, an unclassified glioma, apparently a cerebral medullo-blastoma.

HOWARD P. DOUB, M.D.

**Congenital Cerebral Cysts of the *Cavum Septi Pellucidi* (Fifth Ventricle) and *Cavum Vergae* (Sixth Ventricle): Diagnosis and Treatment.** Walter E. Dandy. Arch. Neurol. and Psychiat., January, 1931, XXV, 44.

The author calls attention to the anatomical relations of these two structures, and reports two cases in which the *cavum septi pellucidi* and *cavum vergae* were markedly dilated with fluid. This was proved by operation. He states that separation of the anterior horn and body of the lateral ventricles, as seen in the ventriculogram, is pathognomonic of the condition. Reproductions of the ventriculograms of these cases accompany the article.

C. G. DYKE, M.D.

**Traumatic Pneumocephalus.** S. W. Miller, R. N. Klemmer, and P. O. Snoke. Jour. Am. Med. Assn., Jan. 17, 1931, XCVI, 172.

One case is reported because of the great damage sustained by the cerebrum, with at least temporary infection, the associated introduction of air into the ventricles, operation, and complete recovery.

In 1926, Dandy reported three cases of intracranial pneumatocele and, in reviewing the literature, found twenty-five other cases. Of these twenty-eight patients, eight definitely had air in the ventricles. In several others there was considerable doubt as to the location of the air. Observers, in explaining the mechanics of the introduction of intraventricular air, presupposed valve action, permitting egress of fluid and ingress of air. Dandy believes an additional factor, such as sneezing, coughing, straining, or even swallowing, is necessary to

force the air from a sinus through rents in the bone and dura into the brain proper.

The important instructive features of the case were: (1) Increasing headache, in a patient with fracture of the skull, should call for roentgenographic re-examination; (2) patients with fracture of the skull involving a sinus should be instructed never to blow the nose; (3) cerebrospinal fistula usually demands operative intervention; (4) the roentgenogram is diagnostic.

CHARLES G. SUTHERLAND, M.D.

**Hypophyseal Lacunar Dysostosis.** Mario Santoro. Archivio di Radiologia, July-October, 1930, VI, 713.

The author describes the case of a boy who had diabetes insipidus. On roentgen examination of the sella turcica, he found a lesion (illustrated in the article) in the cranial bones and similar ones in the ribs, pelvic bones, left humerus, and both femurs. They were at first thought to be due to faulty calcium metabolism secondary to the pituitary lesion, but further examination demonstrated active pulmonary tuberculosis, which the author regards as the most probable cause of the bone changes.

E. T. LEDDY, M.D.

## SPINE (DIAGNOSIS)

**Roentgenologic Findings in a Series of Seventy-two Cases of Traumatic Myelitis Due to Fracture of the Spine.** E. S. Gurdjian. Am. Jour. Roentgenol. and Rad. Ther., January, 1931, XXV, 65.

Although at times very difficult to obtain, the author believes that roentgenograms of all cases of acute spine fractures should be made before any operative procedure is considered. It is important to have good lateral films, being particularly careful, when studying the cervical region, to include the seventh cervical and first dorsal vertebrae. The majority of the cases described had injury at the lower cervical, lower dorsal, and upper lumbar levels. Compression fracture of the cervical vertebrae is not infrequent, and several instances of this

type are described. Longitudinal fracture through the bodies of the vertebræ is a possibility and can be diagnosed from the roentgenogram. The involvement of the spinal cord in fractures of the spine may be either direct or indirect. In the series presented, central softening and hematomyelia were found most frequently in fractures in the cervical region. Edema of the cord after injury is a definite pathologic entity, and is probably responsible for excessive destruction of cord substance. The author concludes that it would, however, be a grave mistake to depend upon roentgen examinations alone.

J. E. HABBE, M.D.

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**Double Isolated Compression Fracture of the Spine.** Chester C. Schneider. *Jour. Bone and Joint Surg.*, July, 1930, XII, 595.

The author states that there have been only twelve reported cases of multiple compression fracture. He adds three more cases which have followed serious accident, and in all of these the involvement is in the thoracic column.

PAUL C. HODGES, M.D.

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**Disabling Back Pain: Differential Diagnosis and Treatment.** Robert McE. Schauflier. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1717.

In considering disabling back pain one must be sure there is no gross lesion, such as a compression fracture of a vertebra or a fracture of the transverse or spinous processes, destructive bone lesion, such as tuberculosis or cancer, or root pain from locomotor ataxia, tumor, or other lesion of the spinal cord. Reflex pain, due to disease or displacement of some viscus, malingering, or a psychoneurosis must be ruled out. Good roentgenograms, both antero-posterior and lateral, will give definite information. Asymmetry of the spine alone is seldom the cause of pain. An increase of the lumbosacral angle might cause chronic strain and pain. Occasional cases of true spondylolisthesis are revealed. The displacement is usually between the fifth lumbar ver-

tebra and the sacrum, or it may be between the fourth and fifth lumbar vertebræ. It must be apparent in the lateral roentgenogram to justify the diagnosis. Congenital malformations of the spine may be puzzling as to whether or not they are the cause of the back pain. Misshapen vertebræ usually lead to deformity early in life, the patient having an abnormal curve of the spine for years. Spina bifida occulta is seldom a cause of back pain. Complete sacralization of the fifth lumbar transverse processes rarely causes symptoms. Unilateral sacralization of the fifth lumbar transverse process is more likely to cause pain because of the unbalance of the spine. Impaction of the transverse process of the fifth lumbar vertebra is seldom a cause of pain. In middle aged or old persons, the roentgenogram often shows hypertrophic arthritis, with rims or spurs in the more advanced cases. One has quite a problem to decide whether or not these changes are the cause of pain.

Comparative data in different series of patients, giving the numbers in which the roentgenographic findings were positive and diagnostic, and in which they showed lesions considered only coincident, are instructive. When there is doubt as to the interpretation, the spine should be immobilized and new films should be made after a two months' interval. The necessity for correlation of a carefully elicited history and comprehensive observation with the roentgenographic findings is stressed.

Treatment is reviewed in all its phases. If other conditions improve but the low back pains remain at the end of six months, hysterectomy in women, and mobilization of the cecum in both sexes, is indicated.

CHARLES G. SUTHERLAND, M.D.

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**Spondylolisthesis.** Henry W. Meyerdinger. *Jour. Bone and Joint Surg.*, January, 1931, XIII, 39.

The author summarizes the findings in 121 cases of spondylolisthesis seen at the Mayo Clinic in the last twelve years. Trauma was a factor in 40 per cent of the cases in which two-thirds were males. Roentgenograms are considered essential aids in making a diagno-

sis. It is practically never possible to reduce the deformity even when it has been caused by recent injury, but the symptoms are relieved by immobilization either by means of belts or by surgical fusion of the lower lumbar vertebrae and the sacrum.

PAUL C. HODGES, M.D.

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The Roentgenogram of Spondylitis Typhosa. Julian Arendt. *Röntgenpraxis*, Dec. 1930, II, 1080.

The spondylitis which follows typhoid is a rather rare disease, only about one hundred cases having been published in the literature. The roentgenologic appearance is dependent on the severity of the lesion and may easily be mistaken for tuberculosis of the spine. Changes in the intervertebral discs and areas of destruction in the vertebrae are commonly seen in a "typhoid spine." Abscesses are not present around the area of infection, the localization usually being in the lumbar spine.

H. W. HEFKE, M.D.

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### THYMUS (DIAGNOSIS)

Roentgenology of the Thymus in Infancy and Differential Diagnoses of Enlarged Thymus and its Treatment. Henry K. Pancoast. *Am. Jour. Med. Sci.*, December, 1930, CLXXX, 745.

This is a very comprehensive article in which the stand is taken that the size of the gland is not the important factor but the thymic menace in infants is largely a matter of tracheal stenosis, aided by relaxation of the soft tissues of the upper respiratory tract. The roentgenologic evidences of thymic enlargement are often erroneous, the only reliable sign of an enlarged or dangerous gland being the buckling of the trachea at the thoracic inlet as it passes over the apex of the gland. This is shown only in a lateral view of the chest, and in the lateral deviation of the trachea in the sagittal view. Unusual width of the shadow is of no particular significance.

Accurate studies of the chest and upper respiratory tract of infants and young children

must be based on two important factors, namely, a uniform and comprehensive technic capable of being reproduced in every instance, and in normal standards for different ages. The technic is described in detail for the taking of films in the erect and horizontal positions, in both sagittal and lateral views. It is essential to examine all thymic suspects in two phases of respiration, if any comparative measurements are to be made. Differential diagnosis is important, and this must not be overlooked just because an enlarged thymic shadow is found. The following conditions have been found in patients suspected of having thymic symptoms: foreign bodies, retropharyngeal abscess, tracheal and laryngeal stenosis, adenoids, asthma, whooping cough, meningitis, congenital heart conditions, congenital atelectasis, collapse of soft tissues, and recurrent laryngeal paralysis.

In the treatment of the gland by irradiation, we are dealing with a lymphatic structure which is extremely susceptible to irradiation, and only sufficient dose should be given to reduce the gland to a safe size. In very early infancy from one-tenth to one-fourth of a mild erythema dose should be given, at 130 K.V., 5 mm. aluminum, nine-inch skin distance, with a slightly larger dose for older children.

W. W. WATKINS, M.D.

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Roentgen Diagnosis and Treatment of Enlargement of the Thymus. Eugene P. Pendergrass. *Pennsylvania Med. Jour.*, September, 1930, XXXIII, 860.

There are certain definite and well founded facts concerning the thymus which are not sufficiently well known and which deserve consideration. The author concurs in the views of Jackson that thymic menace is largely one of tracheal compression. Any roentgenologic technic undertaken in the study of the thymus must include the upper respiratory tract, and also a preliminary fluoroscopic study in essentially the same positions as the roentgenographic views. Sagittal views are made on a low table, with the infant prone upon the cassette. The tube distance is 38 inches and directly over the suprasternal notch. One attendant holds the lower extremities and hips;

another holds the upper extremities above the head, which must be exactly straight, without the slightest rotation to either side and midway between flexion and extension. Exposures can be made in 1/20 sec. and 100 ma. or faster if desired. One exposure is made during expiration and one during inspiration, the child being made to cry for the sake of deeper inspiratory effort. An exact lateral view is also required, the arms being held downward and back, the shoulders thrown as far forward as possible. Use twice the exposure above mentioned, also during expiration and inspiration.

As a result of some experimental work, the author concludes that exposures should also be made in the erect position, an adaptable chair having been devised for this purpose.

In considering radiation therapy of the thymus, it is recalled that the gland is extremely susceptible to radiation, symptoms of enlarged thymus sometimes disappearing after an ordinary X-ray examination. Another important observation, not always remembered, is that the gland can regenerate in from five to ten days. Conservative treatment is advocated, giving from  $\frac{1}{3}$  to  $\frac{1}{4}$  of an erythema dose over the thymic region, and not repeating unless the symptoms either do not disappear or return. An interval of ten days is allowed between treatments and rarely are more than four treatments required. The factors employed are: 130 K.V., 5 ma., 10 in. distance,  $4 \times 4$  in. portal, 5 mm. Al filter, 3 to 4 min. time. Roentgen therapy is almost a specific for enlarged thymus, and if the symptoms do not disappear after several treatments, search should be made for some other cause.

W. W. WATKINS, M.D.

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Thymus. Douglas D. Martin. *Southern Med. Jour.*, July, 1930, XXIII, 625.

The size of the thymus has no relation to the severity of symptoms. The thymus is variable in size, not only in different types of infants, but in the same infant at different times. There is a temporary enlargement of the thymus due to intercurrent diseases. The size of the thymic shadow varies with inspi-

ration and expiration. This author believes that we rarely see cases which require X-ray treatment, and the presence of respiratory stridor, with enlarged thymic shadow, is not sufficient indication for X-ray treatment, without further clinical study.

W. W. WATKINS, M.D.

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### TUBERCULOSIS (DIAGNOSIS)

The Clinical Picture of Calcification of the Mesenteric Glands. Hans Rothmann. *Med. Klinik*, Oct. 24, 1930, XXVI, 1596.

In some cases admitted on account of kidney and stomach symptoms, a calcification of the mesenteric glands could be demonstrated as the cause of the symptoms. All cases showed allergy towards milk and a positive skin reaction with bovine tuberculin. The roentgen examination showed calcification of the mesenteric glands. These findings led to a diagnosis of an old infection of the mesenteric glands with bovine tuberculosis.

H. W. HEFKE, M.D.

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Clinical and Radiologic Observations on Tuberculous Lobitis. Pietro C. Malugani. *Archivio di Radiologia*, July-October, 1930, VI, 763.

The author reports eight cases of tuberculous lobitis involving the right upper lobe and two involving the left upper lobe. This type of pulmonary tuberculosis is easily recognizable by (1) the opacity of the whole lobe, and (2) the sharpness of its outline, which follows the course of the line of the fissure.

E. T. LEDDY, M.D.

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Important Factors in the Study of Childhood Tuberculosis. Stuart Pritchard. *Journal-Lancet*, Sept. 1, 1930, L, 421.

This article is devoted chiefly to a discussion of the importance of contact and the use of tuberculin. Prevention of the disease is augmented by the tuberculin test, repeated physical examination, and X-ray studies. The X-ray is in reality internal inspection and a necessary part of a complete physical examination. Calcification is an excellent sign that

the child has at one time overcome at least a part of his infection, but it is not always evidence of inactivity. All children reacting to tuberculin should have serial X-ray examinations in order to anticipate developing lesions.

W. W. WATKINS, M.D.

**Radiographic Aspects of Laryngeal Tuberculosis.** Lorenzo Feci and Luigi Pietrantonio. *La Radiologia Medica*, August, 1930, XVII, 987.

The conclusions drawn by the author are as follows:

(1) The lateral projections give a clear image of the laryngo-tracheal tube.

(2) In non-laryngeal tuberculosis, the larynx presents early ossification or disseminated zones of calcification.

(3) Radiologically, tuberculosis of the larynx presents: (a) zones of irregular rarefactions of granular or amorphous character and blurred contours in cases of cartilage destruction; (b) in chronic processes there are definite opacities which obscure the normal structure of the trachea.

(4) There is no definite radiological picture which radiologists may use to diagnose the type of pathology involving the larynx. The only information which can be obtained is the extent and the shape of the lesion.

(5) Radiological control in tuberculosis of the larynx has very little value when compared to laryngoscopic examination.

L. MARINELLI.

**Differential Diagnosis of Pulmonary Tuberculosis, Lung Abscess, and Bronchiectasis.** F. P. McNamara. *Jour. Iowa St. Med. Soc.*, September, 1930, XX, 421.

In making such a diagnosis, we utilize the facts derived from a systematic clinical history, a complete physical examination, supplemented by properly directed X-ray and bronchoscopic studies, and by adequate laboratory tests. Too often a history is carelessly taken, a perfunctory physical examination made, laboratory tests neglected, or physicians seem to think it is the X-ray machine rather than the trained radiologist that makes the

diagnosis. From physical findings alone, it is highly improbable that an exact diagnosis can be made, and the other diagnostic aids must be depended upon. The X-ray is of the greatest value, and no diagnosis of lung disease is complete unless checked by the X-ray examination. The long controversy as to whether the X-ray or the clinical findings are the more certain, has no place to-day: a diagnosis is made on all the evidence obtainable. The X-ray will show the location of the lesion, whether it is unilocular or multilocular, whether there is cavity formation, with fluid or air, whether tuberculosis alone is present, or whether it is co-existent with another infection. In ruling out a bronchiectasis, the use of iodized oil may be necessary.

W. W. WATKINS, M.D.

**The Differential Diagnosis of the First Stages of Tuberculosis.** Hans Steininger. *Röntgenpraxis*, Dec. 15, 1930, II, 1105.

Since Assmann and Redeker described the so-called infraclavicular infiltrate, cases have been described which showed a round, homogeneous shadow, especially in the infraclavicular region, as the first manifestation of a lung tuberculosis. The clinical findings are often uncertain and tubercle bacilli cannot always be demonstrated. It would be wrong to always call such infiltrations tuberculosis, as bronchopneumonias and grippe may produce the same picture. These difficulties are shown on repeated X-ray examinations.

The author concludes that it would be erroneous to diagnose a tuberculosis from such findings, in the face of uncertain clinical symptoms.

H. W. HEFKE, M.D.

**The Significance of Advanced Tuberculous Infection of School Children.** Eugene L. Opie. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1151.

Within the past five years, extensive studies have demonstrated the widespread occurrence of grave tuberculous lesions in the lungs of children who do not seem to be sick, and, in many instances, are well nourished and appar-



ently in robust health. These children do not have the symptoms or physical signs usually associated with pulmonary tuberculosis. Tuberculous infection is discovered by the tuberculin test, and roentgenologic examination furnishes a measure of its severity by revealing the extent and character of the lesions. These studies have shown that the transition from latent to clinically manifest disease is often defined with much difficulty, and that some latent lesions are more extensive than those accompanied by symptoms and physical signs. A survey undertaken to discover tuberculosis in children of the public schools and the data from this are reviewed and discussed.

Routine roentgenologic methods are insufficient. Roentgenologic examination applied to the recognition of latent or clinically manifest lesions in children well enough to attend school requires methods specially adapted to examination of the chest, and the interpretation of films demands experience, together with intimate knowledge of the nature and clinical course of the disease. The application of roentgenologic methods to the examination of school children is costly.

In the search for tuberculous infection, two proceedings are available: (1) Examination by tuberculin tests and roentgenologic examination of all children known to be exposed to open tuberculosis; this method would be effective in proportion to the success of tuberculosis registration; (2) roentgenologic examination of school children who react to tuberculin, precedence being given to groups of children, such as adolescent girls and negro children, among whom the disease is known to be unusually frequent.

C. G. SUTHERLAND, M.D.

**Tuberculosis of the Intestine: Its Differential Diagnosis.** J. Arnold Bargaen. *Minnesota Med.*, July, 1930, XIII, 457.

There are two main types of tuberculosis of the intestine, namely, the ulcerative and the hypertrophic. The hypertrophic types must be distinguished from malignancy, actinomycosis, and non-tuberculous pyogenic granuloma. The roentgenogram shows a filling defect, not unlike that of a malignant

lesion, but usually larger. The ulcerative must be distinguished from chronic ulcerative colitis, amœbic ulceration, diverticulitis, polyposis, and malignant disease. The typical X-ray appearance is deformity in the cecum and ascending colon. There is not the immense thickening of the wall common in chronic colitis, and a tendency to persistence of haustra. Writhing and rapid filling and emptying of the ileocecal coil are seen under the fluoroscope. Amœbic ulceration may afford a real diagnostic difficulty, requiring other aids than X-ray for differentiation.

W. W. WATKINS, M.D.

**Suspected Juvenile Tuberculosis: Evaluation of Clinical Symptoms and Signs.** Frederick Eberson, Jessie P. Delprat, and Ernst Wolff. *Am. Jour. Dis. Child.*, October, 1930, XL, 753.

In a series of 306 children with suspected juvenile tuberculosis, the authors found that there was little or no difference between a group with positive and a group with negative tuberculin reactions, as judged by nine symptoms and ten clinical signs. The greatest difference between the two groups seemed to be in terms of nine roentgen observations that were studied. The roentgen observations listed in order of their occurrence, in cases with a positive tuberculin reaction, were: hilum calcifications, increased markings, enlarged bronchial lymph nodes, thickened interlobar pleura, peribronchial infiltration, calcified bronchial lymph nodes, primary focus, thickened apical pleura, and parenchymal tuberculosis.

The evidence presented showed that the commonly accepted clinical signs and symptoms have no diagnostic significance, except as they may be correlated with roentgenograms and tuberculin tests when these are definitely positive for tuberculosis. As a diagnostic criterion, roentgenograms in conjunction with tuberculin tests were unquestionably of value.

According to McPhedran, calcification of the lymph nodes can be recognized only as shadows having a granular appearance. The increase of perihilar shadows is due, not to

enlargement of bronchial nodes, but to pulsation and vibration of the arteries.

Roentgen observations presented the most favorable picture regarding differences between groups with positive reactions to tuberculin and those with negative reactions. However, in relation to the distribution of symptoms and clinical signs, in terms of the more important roentgen evidence, such differences did not exist.

F. B. MANDEVILLE, M.D.

**The Roentgenologic Diagnosis of Tuberculosis of the Suprarenals.** R. Schatzki. *Röntgenpraxis*, Dec. 15, 1930, II, 1130.

Eighty per cent of all cases of Addison's disease have tuberculosis as an etiologic basis. The roentgenologic demonstration of calcified foci of tuberculosis in the adrenals has, heretofore, been described but once, to the author's knowledge. A patient with Addison's disease, whom the author examined, presented definite and marked calcification in both adrenals, so marked that even the anatomical shape of the adrenals was apparent. Calcification may otherwise be shown only in tumors of the adrenals. A few such cases have been described.

H. W. HEFKE, M.D.

**The Childhood Type of Tuberculosis.** Eugene F. Johnson. *Minnesota Med.*, September, 1930, XIII, 613.

Much is being written on the relation between adult and childhood tuberculosis. This paper presents some illustrative cases from the Nopeming Sanatorium. Childhood tuberculosis is the result of a primary infection with the tubercle bacillus and the initial lesion may be anywhere in the lung. Adult tuberculosis is the result of re-infection and the lesions are usually at the apices and along the pleura. The associated tracheobronchial lymph nodes are always involved in the childhood type, while in the adult they are not involved except in the terminal stages. Caseous lesions in the primary type become encapsulated or calcified, whereas, in the adult type they excavate or fibrose, or both. In the childhood type, infiltrative areas commonly resolve, with little evidence, while in the adult

type infiltrated areas resolve, with production of fibrous tissue. These changes are shown by X-ray examination and must be borne in mind in interpreting X-ray densities.

W. W. WATKINS, M.D.

**Hyperplastic Tuberculosis of the Duodenum and Terminal Ileum.** John Day Garvin. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1418.

Hyperplastic tuberculosis of the terminal lower ileum alone, without co-existent involvement of the cecum, is extremely rare. Involvement of the duodenum in the same process has hitherto never been reported. In the case cited here, previous roentgenographic, physical, and proctoscopic examinations were negative in their findings. In August, 1929, the barium flowing into the terminal ileum showed evidence of lack of spasticity or filling and emptying phenomena. To the palpating hand it presented a definite, infiltrated, thickened wall simulating a rope. One month later examination of the stomach gave evidence of obstruction and retention. At operation, tuberculosis of the terminal ileum and involvement of the duodenum with a similar type of lesion, were found. Resection could not be done and subsequent microscopic evidence was not obtained.

In the discussion Reynolds stated that he had found two cases of tuberculosis of the duodenum in the literature, one of which was proved at autopsy.

CHARLES G. SUTHERLAND, M.D.

**The Early Roentgen Diagnosis of Pulmonary Tuberculosis.** Leon J. Menville. *New Orleans Med. and Surg. Jour.*, December, 1930, LXXXIII, 370.

When a pulmonary tuberculous lesion has reached such a size as to produce clinical symptoms, it is susceptible of being visualized on the X-ray film. The roentgen ray is the best single method at our disposal in the diagnosis of early pulmonary tuberculosis. Its accuracy is entirely dependent upon a good technic and a competent and experienced roentgenologist. A complete physical exam-

ination, with a careful history, should be obtained in every case suspected of pulmonary tuberculosis before being sent to the roentgenologist, and consultation should be the rule between the internist and the roentgenologist.

W. W. WATKINS, M.D.

### TUBERCULOSIS (THERAPY)

**Sun and Occupational Therapy for Surgical Tuberculosis Patients without Means.** A. Rollier. *Strahlentherapie*, 1931, XXXIX, 213.

The author briefly describes in this article the international clinic shops which permit an occupation of the tuberculous patients during their stay in the Sanatorium. Even cases of spondylitis can do some work, as is illustrated in an accompanying picture showing a man lying in his bed on his stomach while using an electric drill placed near the head of the bed. This new development facilitates the return of the cured patients to the home and community as self-supporting citizens.

ERNST A. POHLE, M.D., Ph.D.

**The Present Status and Importance of Deep Roentgen Therapy of Tuberculosis of the Lungs.** H. Schulte-Tigges. *Röntgenpraxis*, Nov. 1, 1930, II, 983.

The animal experiments, clinical experience of others, technic, and indications for roentgen therapy of tuberculosis of the lungs are reviewed. Two hundred eighty-six patients have been treated during the last ten years, and the end-results seem very favorable and are much better than the results achieved by other sanatoria which do not use roentgen treatment. Careful selection of the patients, small doses of X-rays, and continued supervision of the patient are essential for a successful roentgen therapy.

H. W. HEFKE, M.D.

**Phrenic Nerve Operations in Pulmonary Tuberculosis: Results in Five Hundred Cases.** E. J. O'Brien. *Jour. Am. Med. Assn.*, August 30, 1930, XCV, 650.

This is a review of the results in five hundred cases. Three hundred and seventy-eight were operated on for cavitation: in 50.5 per

cent the cavities closed, and in 31.2 per cent they became smaller. Results proved more effective in moth-eaten cavities and in those with soft walls, especially the smaller ones. The best results were obtained with cavities at the base of the lung. In many instances the results of phrenicectomy were beyond expectations.

The combination of artificial pneumothorax and phrenicectomy was especially effective in accomplishing closure of cavities in the author's series.

In a series of tables, the results are tabulated in their different phases. Phrenicectomy is not an operation to be considered lightly. The results, however, are sufficient to warrant its more extensive use.

CHARLES G. SUTHERLAND, M.D.

**The Limitations of Heliotherapy in Pulmonary Tuberculosis.** Bernard Langdon Wyatt. *Ann. Int. Med.*, October, 1930, IV, 376.

Heliotherapy, as defined by the writer, means the direct exposure of the surface of the body to the direct rays of the sun, although indirect effects will be produced by sky reflection and from air currents.

Patients with the so-called "surgical" forms of tuberculosis were not included in the series since the lung involvement is usually minimal, with a tendency to become quiescent rapidly. The number of patients showing appreciable improvement that might be attributed solely to direct heliotherapy was negligible.

The results derived from direct heliotherapy in pleural tuberculosis were most gratifying. Very satisfactory results were secured in tracheobronchial lymph-node involvement. The author believes that heliotherapy is of great value in preventing intrapulmonary extension from hilum tuberculosis, and quotes Mayer, of Saranac Lake, as follows: "When I think of extra-pulmonary tuberculosis I immediately think of light. On the other hand, when I think of pulmonary tuberculosis, I do not think of light. . . ."

C. H. DEWITT, M.D.

**Tuberculous Spondylitis: Its Clinical Symptoms and Curative Results Following Sunlight and Fresh Air Treatment.** Eugen Kisch and Hans Berger. *Strahlentherapie*, 1930, XXXIX, 109.

The authors report in this paper the results obtained in tuberculous spondylitis at the Tuberculosis Sanatorium of the City of Berlin. Of the 563 patients suffering from spondylitis which were seen during the past ten years, 94 (or 16.7 per cent) had paresis. In the majority of the cases, three or more vertebrae were diseased. Fifty-one of the patients (or 54.3 per cent) were cured clinically and roentgenographically. Twenty-three (24.5 per cent) were considerably improved and could be discharged; ten (10.6 per cent) had to be discharged unimproved mainly because of financial or social reasons; ten (10.6 per cent) died during the treatment. The average duration of treatment for the 51 cured cases was nineteen months.

ERNST A. POHLE, M.D., Ph.D.

### TUMORS (DIAGNOSIS)

**A Case of Perithelioma of Fascial Origin, with a Direct Antecedent History of Trauma.** T. Valentine Cooper. *Lancet*, Dec. 6, 1930, CXIX, 1234.

The tumor in this case was interesting because of its unusual histological appearance and because of its close relationship to a previous injury. The patient was a woman, aged 58, who had been struck near the elbow-joint. A lump appeared immediately after the injury. She was able to use her arm, but as the lump enlarged to the size of a pear, and numbness and anesthesia over the distribution of the ulnar nerve appeared, with wasting of the innervated muscles, a piece of the mass was removed under general anesthesia for microscopic examination. A preliminary diagnosis of fibrosarcoma was made and the arm was amputated. From the section, the tumor apparently had its origin in the fascial intermuscular sheaths or septa. Microscopically, the section had the appearance of a tumor which has been classified as a perithelioma, in accordance with current teaching, although

the author believes that on further investigation it seems probable that such a classification rests on very insecure and unscientific foundations. He suggests the name "perivascular sarcoma" for the tumor described, for this name gives a definite indication of the histological appearance, and does not produce confusion regarding the site and mode of origin.

H. J. ULLMANN, M.D.

**Giant-celled Tumor of the Upper Jaw.** H. W. Coates. *Can. Med. Assn. Jour.*, May, 1930, XXII, 681.

This is a case report of a patient thirty-eight years of age. The tumor had been removed ten years previous to the date of this report. In size it was one and three-quarter inches by three-eighths of an inch. It was situated on the right upper alveolus and attached by a pedicle connected with the interior of the antrum through a perforation. The affected part of the superior maxilla was removed radically. The pathological report was giant-cell sarcoma.

At this date, ten years after the operation, the patient is well, and there is no evidence of the return of the growth.

L. J. CARTER, M.D.

**The Diagnosis of Tumors Involving the Spinal Cord.** Henry W. Woltman. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1398.

This essay reviews the diagnosis, which is the phase of particular interest to medical men and which has, as its natural sequence, proper treatment. The patient's story is the most important step in the diagnosis. The earliest and commonest complaint is pain. The pain may be in the spine at the site of the tumor; it may be referred to the lower extremities even when the tumor lies high in the canal, but usually it is referred along the distribution of a posterior root, when it is known as a root pain. Root pains are segmentally distributed. The pain becomes more and more intense as tumors grow. Anything which suddenly increases the pressure of the spinal fluid aggravates the pain. Root pains have a habit of awakening the patient from sleep at 3 or 4 o'clock in the morning. Disturbances of

motility are evidenced in a slowly progressive weakness; the muscles become atrophied, weak and toneless, and their reflexes become correspondingly feeble. Disturbances of sensibility and sphincteric control add to the discomfort of the patient.

Roentgenography occasionally reveals erosion of bone produced by a tumor, or even a calcified tumor itself. It is also one of the most certain methods of excluding metastatic tumors and other diseases of bone. The introduction of an opaque medium, such as iodized oil, into the subarachnoid space through cisternal or lumbar puncture, usually does not help a difficult situation. Its use in differential diagnosis is limited and the preparations commonly used are somewhat irritating to the meninges. Differential diagnosis may be difficult. A discussion of the simulants follows. Repeated examinations may be necessary in order to establish a diagnosis. Exploration without definite indication of the correct level of disturbance is almost certain to result in disappointment.

CHARLES G. SUTHERLAND, M.D.

**Changes in the Kidney Pelvis on the Roentgen Film Caused by Extra-renal Tumors.** Robert Bachrach and Karl Hitzenger. *Röntgenpraxis*, Nov. 1, 1930, II, 990.

Extra-renal tumors (liver, gall bladder, spleen) may change the shape of the kidney pelvis in a pyelogram by pressure in such a way that a differentiation of such a tumor from a renal neoplasm is not possible by means of a pyelogram. This fact is rarely mentioned in the literature. Eight case reports are given, with a reproduction of the deformities of the pelvis, in which four were caused by splenic tumors and four by the liver and gall bladder.

H. W. HEFKE, M.D.

**Multiple Myeloma as a Single Lesion.** Charles F. Geschickter. *Ann. Surg.*, September, 1930, XCII, 425.

Geschickter and Copeland, in 1928, published a complete review of the literature on multiple myeloma, and added 13 case reports.

The six cardinal diagnostic features of the disease are: (1) Multiple involvement of the skeletal trunk by tumor formation in an adult over 35 years of age; (2) pathologic fracture of a rib; (3) the presence of Bence-Jones bodies in the urine; (4) lumbar backache, with signs of early paraplegia; (5) an otherwise inexplicable anemia; (6) a chronic nephritis, with nitrogen retention and low blood pressure.

The author presents in detail a case of a white male, 45 years of age, who showed evidence of only a single bone lesion, diagnosed as myeloma. He cites another case in a man 37 years of age, in which later films showed progression to other bones.

A brief discussion limited to differential diagnosis from giant-cell tumor, Ewing's tumor, and metastatic carcinoma is given, and the author concludes that a primary bone destructive lesion occurring centrally in a single bone, in the shaft of an adult, without expansion of the bone shell, should always excite suspicion of malignancy. Rarely the lesion may be a latent bone cyst; most frequently it is a metastatic carcinoma, but occasionally a multiple myeloma. The entire skeleton and lungs should be examined by the X-ray, for in this way the multiple myeloma or metastatic bone tumor, both hopeless diseases, may be disclosed and an unnecessary operation avoided. The urine must be examined for Bence-Jones bodies.

F. B. MANDEVILLE, M.D.

**Discussion of the Opaque Formations in the Abdomen, with Special Regard to Dermoid Cysts and Splenic Calcifications.** Alessandro Vallebona. *La Radiologia Medica*, April, 1930, XVII, 365.

The author deals with the different shadows which may be observed in the abdomen, and discusses the difficulties offered by a diagnostic parallel. Special attention is given to the calcareous shadows which are apt to be overlooked by the radiologist, and to the differentiation of endocavitary deposits from calcic sediments in the tissues and from the shadows frequently observed in tumors and parasitic localizations. A comprehensive discus-

sion is given concerning various techniques the radiologist may resort to in locating them, and regarding the difficulties encountered in determining their intrinsic nature, and the organ in which the calcifications are located.

The author gives a complete description of the images of phlebolites, and illustrates some observations on calcification of the lymphatic gland and the peritoneum. He reports two cases of dermoid cysts of the ovary and two cases of calcification of the spleen.

L. MARINELLI.

**The Deposit of Active Bismuth in Malignant Tumors.** Herbert Kahn. *Strahlentherapie*, 1930, XXXVII, 751.

The author presents a preliminary report of his experiments dealing with the effect of a bismuth preparation on human carcinoma when injected intramuscularly or intravenously. It was possible to deposit as much as 8 mgs. per cent without ill effects. A series of animal experiments supported the contention that tumor tissue deposits more bismuth than normal tissue. A combination of bismuth injections with irradiation seems also to be promising. The author, therefore, invites his colleagues to the further study of this therapeutic procedure.

ERNST A. POHLE, M.D., Ph.D.

**Radiological Diagnosis and Radiation Therapy of Tumors of the Pituitary Body.** Quintino Vischia. *La Radiologia Medica*, April, 1930, XVII, 409.

The author reports two cases of tumor of the hypophysis treated by roentgen rays. A detailed description is given of the symptomatology, the radiological aspect, and the prognosis of this disease. He is generally in favor of radiation therapy in almost all the stages of the growth, because he considers it the most safe and the one which is the most likely to yield satisfactory results. The author observed in one of the patients thus treated a partial reconstruction of the sella turcica, and accounts for this phenomenon on the grounds that X-rays stimulate, in the irradiated region, a cerebral zone which controls

calcium metabolism. This would contradict the experimental findings of others who have noted a decrease in the calcium content of the blood after irradiation of the same zone.

The author concludes that in any case it is logical to assume the existence of a center, regulating calcium metabolism of the body.

L. MARINELLI.

**A Case of Sarcoma Botryiodes Corporis Uteri.** P. J. Kearns. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 418.

This is a case report of a very rare condition, the first to be recorded in the Clinic of the Women's Pavilion of the Royal Victoria Hospital, Montreal. A tumor, associated with the uterus, was found on operation to be a firm, grape-like, nodular mass the size of a four months' pregnancy, growing from the top of the uterus. Pathologic examination showed a partly edematous, partly myxomatous, partly lymphangiectatic spindle-cell sarcoma.

L. J. CARTER, M.D.

**Periosteal Lipoma: Report of Two Cases.** Edwin I. Bartlett. *Arch. Surg.*, December, 1930, XXI, 1015.

The author reports two soft tissue tumors which were sharply delimited, one lying in the soft tissues of the upper arm just above the elbow, and the other in the upper portion of the lower leg just below the knee. They were slightly lighter in density than the surrounding structures and had fan-like, radiating markings not bony in character. At operation these were found to be benign lipomas. They lay in immediate contact with the bone and were removed from it by sharp dissection. The periosteum below it was somewhat thickened, but the tumor came away intact.

HOWARD P. DOUB, M.D.

**Lipoma of the Mediastinum.** Wallace M. Yater and E. Stuart Lyddane. *Am. Jour. Med. Sci.*, July, 1930, CLXXX, 79.

The authors review the literature on 11 cases of previously reported lipomata of the mediastinum, and add one more case of their own,

that of a male, aged 44, who entered the hospital with symptoms of lobar pneumonia. On autopsy a lipoma was revealed, arising from the anterior mediastinum and weighing  $8\frac{3}{4}$  pounds. It displaced a large part of the right lung and extended over to the left side, partially covering the pericardium. Microscopic sections of the tumor showed that it was a pure lipoma. Lipomata may arise either from the mediastinum, the endothoracic fascia, or from the sub-peritoneal fat, forcing its way through the fibers of the diaphragm.

They conclude their article with a table including all the salient data of the 12 cases of lipoma of the mediastinum which have been reported.

ROE J. MAIER, M.D.

**Hypernephroma with Virilism in a Child of Three Years.** G. W. Harris and D. F. Plewes. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 244.

Tumors of the suprarenal cortex accompanied by virilism are rare, only 24 cases having been reported prior to this one.

This case, reported from the Brantford Clinic, was one of left hypernephroma accompanied by virilism. The evidences of the latter were abundant pubic hair, deepened voice, and the development of the clitoris to a length of one and one-half inches.

The hypernephroma was successfully removed. Ten months later the secondary sexual characteristics were remaining stationary, while there was no sign of recurrence of the tumor.

L. J. CARTER, M.D.

**Forcing the Demonstration of Canalization in Tumors of the Colon and Non-recognized Invagination of the Tumor.** A. W. Fischer. *Röntgenpraxis*, Dec. 15, 1930, II, 1114.

In order to make a differential diagnosis between a benign and malignant tumor of the colon, one should not be satisfied to demonstrate only a filling defect or the Stierlin symptom, but should try to visualize the canalization itself. The shape of the tumor will assist in making a more definite diagnosis.

It is often easy to show the canalization, but sometimes barium may be forced through only by inflation with air. The narrowing of the bowel lumen, so often explained by the tumor itself, is caused many times only by an invagination of a comparatively small tumor.

H. W. HEFKE, M.D.

**Three Primary Malignant Epithelial Tumors of the Ano-rectal Region Occurring in One Person.** D. M. Angevine. *Canadian Med. Assn. Jour.*, July, 1930, XXIII, 38.

This is the first case recorded, so far as the author can determine, in which three primary malignant tumors were so closely related anatomically. The case came into the clinic of Dr. C. P. Howard in the Montreal General Hospital.

At autopsy a large squamous-cell carcinoma almost encircled the rectum just above the anal canal. In addition, there were two other firm areas at the mucocutaneous junction. One of these was an adenocarcinoma, while the other was a malignant tumor of the peri-anal mucous glands. Numerous metastases were found in the liver, lungs, lymph nodes, vertebræ, and ribs, and all were of the squamous-cell type.

L. J. CARTER, M.D.

**Sarcoma of the Stomach: Report of Four Cases and Review of the Literature.** Rigney D'Aunoy and Adelaide Zoeller. *Am. Jour. Surg.*, September, 1930, IX, 444.

Sarcoma of the stomach comprises about 1 per cent of gastric malignancies. There are no pathognomonic features which give a pre-operative diagnosis. This is accomplished by a histological examination of an excised portion of the tumor or of one of its metastases. Roentgenologically, these tumors are impossible of differentiation from carcinoma.

They tend to occur at an earlier average age than does carcinoma. The prognosis of gastric carcinoma would appear to be slightly better than that for sarcoma, as the former does not appear to metastasize so readily or so early. Three hundred and thirty-five cases of sarcoma of the stomach, including the four

reported in this article, are recorded in medical literature for the year of 1929.

HOWARD P. DOUB, M.D.

### TUMORS (THERAPY)

**Multiple Myeloma: Report of Case.** Lloyd Bryan and Joseph Levitin. *California and Western Med.*, January, 1931, XXXIV, 15.

The authors report a case of multiple myeloma in which pain, the outstanding symptom in these conditions, was well controlled with X-ray therapy. This patient lived three and one-half years after the onset of the condition, which is nearly twice the average time. They discuss the clinical symptoms, laboratory findings, and differential diagnosis of multiple myeloma. The therapy used is only palliative, but in this case there was also a certain amount of new bone laid down, following the X-ray therapy. The article is illustrated with cuts of X-ray films and microscopic sections.

FRANCIS B. SHELDON, M.D.

**The Reaction to Irradiation as a Means of Differentiating Certain Varieties of Tumor.** Arthur U. Desjardins. *Brit. Jour. Radiol.*, January, 1930, III, 6.

Every variety of cell in the body and every organ or structure made up wholly or largely of one variety of cell, has a specific sensitiveness to the X-ray or radium ray. The lymphocytes in the spleen, lymph nodes, intestinal lymph follicles, bronchial nodes, thymus gland, and circulating blood are most sensitive, next to which come the spermatogonial cells of the testis, and basal epithelium of the ovarian follicles. In certain types of tumors included in the groups classified as lymphoblastomas and embryonal carcinomas of the testis, the tumor response to irradiation may prove a more accurate criterion to diagnosis than a microscopic study of the small biopsy specimen, since the irradiation test involves the whole tumor, while the biopsy study may include only the less important element of the tumor. Lymphosarcomatous tumors may

react even more rapidly than Hodgkin's disease or lymphatic leukemia, although in the average case the difference is scarcely recognizable.

The author calls attention to a group of tumors arising around the base of the tongue, tonsils, and nasopharynx which, microscopically, resemble epithelioma, but contain a considerable portion of lymphoid cells which are quite radiosensitive. These tumors have been called lympho-epitheliomas, a term which may be objectionable in the eyes of the pathologist, but serves to indicate their satisfactory response to therapeutic irradiation.

The only other tumor closely approaching the lymphoblastomas in irradiation response is the pure embryonal carcinoma of the testis. The mixed or teratoid tumors of the testis are much less responsive, and hence less effectively controlled.

The typical response of the benign giant-cell tumor to a moderate dose of rays is, at first, swelling, with redness and pain a few days after the exposure, but after about two weeks the swelling and redness disappear, and over a period of from six to twelve months the tumor area is usually replaced by dense bone.

Malignant tumors of bone are rarely very responsive to treatment, although usually Ewing's endothelial myeloma and the chondrosarcoma will show a prompt initial response to irradiation.

J. E. HABBE, M.D.

**Tumors of the Parotid Gland.** Edward B. Benedict and Joe V. Meigs. *Surg., Gynec. and Obst.*, November, 1930, LI, 626.

This is a report based upon the study of 225 cases of parotid gland tumor from the records of the Massachusetts General and the Collis P. Huntington Memorial Hospitals. The etiology, pathology, occurrence, signs and symptoms are discussed. Under the heading "treatment," the following statement is given: "The treatment in practically all cases should be operative. Radium or X-ray treatment in our experience has been only palliative, never curative. Moreover, without operation, no pathological report is obtained, so that, not



knowing with what type of tumor we are dealing, the treatment may be unsatisfactory, and no conclusions can be drawn from it. In a very large malignant tumor, in which there is no hope of cure, radium or X-ray may be used—chiefly valuable in recurrent malignant tumors. We are aware that some surgeons may have a higher regard for radiation treatment than we have, but certainly in this relatively large series of carefully followed cases, there is no evidence for attributing the permanent cure of a single parotid tumor to the use of X-ray or radium."

The authors summarize as follows:

1. Benign tumors are more common than malignant tumors in the ratio of about four to three.

2. Carcinoma is about twice as common as sarcoma.

3. Cysts, melanotic sarcomata, and adenomata are extremely rare.

4. Mixed tumors are essentially benign, but recur locally with great frequency. They rarely become malignant.

5. Malignant parotid tumors are very difficult to cure, and early radical operation is advised.

6. Patients with mixed tumors live indefinitely, while those with malignant disease rarely live over two years after operation.

7. Radium and X-ray are useful in the treatment of malignant parotid tumors, but only as palliative procedures. In the treatment of benign parotid tumors, radiation therapy is of benefit in some cases, but we believe excision is the treatment of choice.

8. Carcinoma, sarcoma, and malignant lymphoma may invade the parotid gland secondarily. Such cases usually end fatally, but one brilliant cure reported here justifies many extensive operations and emphasizes the importance of not giving up in our struggle against malignant disease.

D. S. CHILDS, M.D.

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**Intrathoracic, Extra-pleural Granulation Tumors.** Otto Dyes. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 45.

The paper contains a discussion of attempts at roentgenologic differentiation of pathology

of the thoracic cage, the pleura and peripheral pulmonary areas. For interpretation of marginal chest shadows, when tuberculosis, actinomycosis of thoracic cage, pleura or peripheral lung areas, pleural endothelioma, carcinoma, sarcoma—primary, as fibrochondromyxoneuro-sarcomata, or the more frequent metastatic—encapsulated pleural effusion, or lipoma have to be differentiated, considerable information may be obtained. However, especially in the cases of large tumor masses, often one cannot arrive at an etiological diagnosis.

The paper is illustrated by a few cases of tuberculous granulomata, forming dumb-bell shaped masses, partly in epicostal, partly in subcostal but extra-pleural location, and arising from small areas of caries in the ribs. It is stated that radiation treatment in doubtful cases may be used as a diagnostic aid, since tuberculous granulations are usually quite responsive to medium doses of roentgen therapy, while, for instance, actinomycosis requires much more intense irradiation.

HANS A. JARRE, M.D.

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**A Few Cases of Sarcoma of the Uterus Treated by Irradiation.** Cl. Regaud and A. Lacassagne. *Strahlentherapie*, 1930, XXXVII, 275.

The *rationale* of the treatment of uterine sarcoma is a much discussed problem. In this article the histories of six cases are fully related, accompanied by microphotograms of the different types of tumors. One case was treated in 1920 with radium alone. Since the methods used at that time are not comparable with the modern procedure, they cannot be used in the compilation of results. In only two cases could the complete irradiation (radium internally and X-rays externally) be carried out. In the three remaining women, the systemic reaction due to rapid tumor tissue destruction prevented further treatment. One completely treated patient is still free from symptoms three and one-half years later; in all the others, death occurred within six months following the beginning of the treatment. In operable cases, therefore, surgery

should be combined with pre-operative irradiation. Caution is indicated in inoperable tumors because of the possibility of aggravating the condition of the patient, due to infection resulting from the necrosis of the tumor.

ERNST A. POHLE, M.D., Ph.D.

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**The Management of Giant-cell Sarcoma of the Vertebrae: Report of a Case with Cure after Five Years.** John O. Bower, Jefferson H. Clark, and Leon Davis. *Arch. Surg.*, August, 1930, XXI, 313.

From the experience of the authors, they believe that giant-cell tumors of the vertebrae should not be considered benign, as compared with giant-cell tumors of the bone elsewhere. These tumors possess the tendency to metastasize rarely, to recur commonly, and to produce cachexia invariably. Operation is a very difficult procedure in the vertebrae, and in over one-half of the cases there were local recurrences.

The authors believe that the best treatment for this type of tumor is the insertion of radium into or near the growth, with as little trauma as possible. Giant cells are peculiarly susceptible to radium rays.

HOWARD P. DOUB, M.D.

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**Irradiation Therapy of Malignant Tumors in Sweden.** Gösta Forssell. *Wien. klin. Wchnschr.*, Sept. 18, 1930, XLIII, 1161, and Sept. 25, 1930, XLIII, 1194.

The conditions at the Radiumhemmet gave an excellent opportunity to draw conclusions about the irradiation therapy of malignant tumors. Not only could inoperable patients be treated with X-rays and radium, but a great many borderline cases and operable cases, as well, were treated by means of radiotherapy only. The follow-up of the patients could be so perfected that the statistics, since 1910, are almost complete. Irradiation therapy alone led to a five-year cure in skin carcinomas in 69 per cent of all cases, and in 78 per cent in operable cases. Surgical end-results, taken from a large group of Swedish statistics, show a five-year cure in 65 per cent in the

operable group. In carcinoma of the lip, radiotherapy reached 68 per cent of five-year cures, and surgery 62 per cent. Included in the irradiated group, however, were 20 per cent of inoperable cases. Carcinomas of the oral cavity, of which 75 per cent were inoperable, showed 18 per cent of five-year cures when treated by radium and X-rays. Surgery was responsible for 41 per cent of five-year cures in carcinoma of the tongue with metastases, while irradiation brought the percentage up to 60. Carcinomas of the cervix uteri, of which 75 per cent were inoperable or borderline cases, showed a five-year cure in 26.6 per cent with irradiation, 18 per cent with surgery. If one considers operable and borderline cases only, the percentage is 40.4 by irradiation and 35.6 by surgery. Carcinoma of the corpus uteri showed about the same results (43 per cent) by either means of treatment. Twenty-four per cent of all primary sarcomas could be cured for five years, the greatest number of all cases being inoperable; 18 per cent of recurrences after operation could still be cured.

These results permit of the conclusion that irradiation therapy in these tumors stands very well compared with surgery alone. For carcinoma of the skin, lip, and uterus, irradiation therapy should be considered the method of choice, sometimes in combination with surgery. Good results by X-ray and radium can be achieved in other tumors also, as carcinoma of the thyroid, vulva, ovaries, and breast, but only inoperable cases have been treated and statistics are not available as yet. A combination of surgery or electrocoagulation with irradiation has been used more and more during the last ten years. Such a combination has led to 77 per cent of three-year cures in carcinoma of the lip, 75 per cent of three-year cures in carcinoma of the tongue, and 80 per cent in oral carcinoma without metastases. For carcinoma of the breast, pre- and post-operative irradiation is the method of choice. Combined surgery and irradiation prolongs the life of such patients longer than surgery alone, and local recurrences in the irradiated fields are comparatively infrequent. Radiotherapy in combination with surgery ought to be the

method of choice in carcinomas of the mouth, the maxilla, the breast, the pharynx, the thyroid, the ovaries, and the external female genitalia. In borderline cases of carcinomas of the pharynx and thyroid, irradiation alone should be employed. In 40 per cent of all cases of carcinoma, irradiation therapy either with or without surgery is indicated; the other 60 per cent, however, belong to the surgeon alone, including all carcinomas of the digestive tract. Of 4,470 carcinoma patients from 1921 to 1927, 38 per cent were symptom-free for shorter or longer periods; 24 per cent of all sarcomas could be made symptom-free. The palliation produced by radiant energy should not be minimized, and the above results give some indication of such action.

Only well equipped centers are able to develop irradiation therapy to such an extent that it may compete with surgery. Co-operation between the surgeon and the radiologist is essential to good results. Radium and X-rays alone cannot cure a carcinoma—able and well trained physicians must administer them.

H. W. HEFKE, M.D.

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**Three Cases of Neuroma: Cirroid Neuroma of Face; Neurofibroma of Stomach; Posterior Tibial Neurofibroma.** James T. Case. *Am. Jour. Surg.*, March, 1930, VIII, 648.

Three cases of nerve tumors of the neurofibroma type are described.

The first case was an extensive cirroid neurofibroma of the head and face, with roentgen evidence of bone changes in the frontal and parietal area, and distortion of the facial bones. This was treated by combined surgical and roentgen therapy and the patient has remained well for fifteen years. Inasmuch as this had previously recurred following surgical treatment alone, it is suggested that radiation therapy should be applied to these cases either alone, or as a supplement to surgical intervention.

The second case was a large neurofibroma of the posterior wall of the stomach near the pylorus.

The third case was a neurofibroma of the

posterior tibial nerve. This can be seen on a plain roentgenogram as a soft-tissue shadow.

H. P. DOUB, M.D.

### ULTRA-VIOLET LIGHT

**The Use of Ultra-violet Light (Osram-Vitalux-Lamp) in Diseases of the Respiratory System.** A. Moeller. *Med. Klin.*, June 13, 1930, XXVI, 887.

During his studies of the influence of ultra-violet radiation on diseases of the respiratory system the author found that beginning colds frequently may be checked, especially with radiation through the open mouth. Light therapy in pulmonary tuberculosis should be handled very carefully. All cases of active tuberculosis, especially of the exudative type, should be excluded from any light therapy. An elevated temperature and hemoptysis are contra-indications also. In chronic cirrhotic types and in the productive type one can use light therapy with success. The treatment should be done very carefully and the dose should be varied according to individual indication. One must realize that the action of the ultra-violet rays on the lung tissue must be an indirect one. Treatment of bronchial and cardiac asthma has not been successful. In tuberculosis of the hilum glands one may notice a distinct decrease in size only after irradiation for several months.

H. W. HEFKE, M.D.

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**The Dosage of Ultra-violet Radiation in Infants with Tetany.** Harry Bakwin and Ruth Morris Bakwin. *Jour. Am. Med. Assn.*, Aug. 9, 1930, XCV, 396.

There is a widespread impression that, if excessive skin irritation is avoided, the greater the amount of ultra-violet radiation given, the better. Numerous observations indicate that the effect is not proportional to the dosage and that an effect produced by a smaller dose may be reversed when a larger dose is given. When cholesterol or ergosterol is irradiated, the antirachitic potency rises for a time and then falls as the irradiation is continued.

The effect of measured amounts of ultra-violet radiant energy on the serum calcium of

twenty-eight infants with tetany was studied. The intensity of radiant energy was measured by the oxalic acid-uranyl sulphate method of Anderson and Robinson.

In the use of ultra-violet radiation for infants with tetany, there is an optimal range of dosage above and below which the rate of rise in the serum calcium is slowed. A daily dosage of two minutes front and two minutes back at 50 cm. is optimal unless the burner is badly deteriorated.

When large enough doses of ultra-violet radiation are used, the average daily rate of rise in the serum calcium of white and of Negro infants with tetany is about the same, but the minimal dosage necessary for cure is greater in Negro than in white infants.

CHARLES G. SUTHERLAND, M.D.

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**On the Ultra-violet of the Sun.** Ch. Fabry and H. Buisson. *Strahlentherapie*, 1930, XXXVI, 410.

**The Intensities of the Short Ultra-violet Rays in the Sun Spectrum.** F. W. Paul Götz. *Strahlentherapie*, 1930, XXXVI, 429.

The paper by Fabry and Buisson presents data on the amount of radiation emitted by the sun as compared with the amount reaching the earth. It concludes with a graphic presentation of the composition of the ultra-violet in the sun spectrum after passing through the atmosphere.

Götz offers the results of measurements carried out in Arosa on a clear summer day, and compares the erythema effect of the ultra-violet in the sun before and after filtration through the atmosphere.

ERNST A. POHLE, M.D., Ph.D.

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**Osteitis Deformans: Its Treatment by Ultra-violet Rays.** Clement Nicory. *Brit. Med. Jour.*, March 15, 1930, No. 3610, p. 492.

Case histories are given of four patients with osteitis deformans treated by irradiation with ultra-violet light, using a mercury vapor lamp. Over a period of three years these cases have shown a complete disappearance of symptoms, with a marked return of the

bones to normality. Comparative X-ray films are reproduced.

The author publishes these cases with a view to getting a greater number of patients treated by this method, and having his findings confirmed or otherwise.

WALLACE D. MACKENZIE, M.D.

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**Ultra-violet Light in the Treatment of the Dull and Backward Child.** Frank Sugden. *British Med. Jour.*, Nov. 29, 1930, No. 3647, p. 905.

The author has had considerable experience in the institutional treatment of dull and backward children, and has been impressed by the improvement in the standard of mentality of many of the cases under treatment by actinotherapy. He suggests that as there is no definite line of demarcation between the dull and backward and the mentally deficient type, it is reasonable to assume that patients may be selected and their standard of mentality be considerably raised by actinotherapy. The same standard of improvement cannot be expected to obtain in every case, but, with the exception of those children who turn out to be of definite mental deficiency, it is very exceptional to find one who will not show signs of both physical and mental development.

WALLACE MACKENZIE, M.D.

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**On a Case of Similar Effect of Ultra-violet and of Roentgen Rays.** K. Brummer. *Strahlentherapie*, 1930, XXXVI, 716.

In white rats weighing from 40 to 60 grams, rickets was produced by omitting vitamins from their food. After three weeks, roentgenograms were taken as a control, and a part of the animals was then treated with ergosterol which had been activated by roentgen rays of long wave length. The ergosterol had been irradiated in powder form by roentgen rays produced at 7 K.V., 10 ma., 3 cm. F.D., for 60 seconds and also for 60 minutes. Each rat received 0.0006 mgs. ergosterol per day. The control rats were kept on the same amount of unirradiated ergosterol. The rats which had received the irradiated ergosterol for three weeks did not show any signs of

rickets and had gained from 20 to 30 grams. The control animals showed severe symptoms of rickets and two had died before the end of three weeks.

The author concludes from these experiments that roentgen rays of long wave length can also activate ergosterol.

ERNST A. POHLE, M.D., Ph.D.

**Symposium on Ultra-violet Therapy.** Med. Jour. and Record, Dec. 17, 1930, CXXXII, 591.

This is a series of articles on various aspects of ultra-violet therapy, as follows: "Different Methods of Applying Ultra-violet Radiation," by W. Kerr Russell, of London, England; "Biological Studies of Sunlight Filters," by Walter H. Eddy, of New York; "The Status of Window Materials for Transmitting Ultra-violet Radiation," by W. W. Coblentz, of Washington, D. C.; "The Measurement of Therapeutic Ultra-violet," by Roger S. Estey, of New York; "The Tungsten Arc as a Source of Ultra-violet Radiation," by W. J. Turrell, of Oxford, England; "The Decrease in Ultra-violet and Total Radiation with Usage of Quartz Mercury Arc Lamps," by William T. Anderson, Jr., of Newark, N. J.; "Sunshine for Therapeutic Use," by M. J. Dorcas, of Cleveland, Ohio.

The series of papers constitutes a good review of the technical and physical phases of ultra-violet radiation, and are recorded here, without abstracting, for the information of those who may be looking for such references.

W. W. WATKINS, M.D.

**The Effect of Ultra-violet Radiation on Tissue Cultures.** Edmund Mayer. *Strahlentherapie*, 1930, XXXIX, 148.

In this paper, the results of extensive experiments concerning the effect of visible light or ultra-violet light alone, and of a combination of both—of an ultra-violet line or a continuous spectrum—on fibroblast cultures are reported. A quartz mercury vapor lamp and a Vitalux lamp served as sources of radiation. It appears that visible light alone inhibits the growth and that ultra-violet light alone inhib-

its it more or less. For the effectiveness of ultra-violet light, the presence of visible light is quantitatively without any influence. The continuous ultra-violet spectrum produces the same effect as an ultra-violet line spectrum. The various degrees of inhibition of growth can be brought about by varying the exposure time and by any combination of ultra-violet rays. It seems, therefore, that the inhibition of growth in tissue cultures may be used as a biologic measurement method for ultra-violet radiation. Numerous graphs and a few photomicrograms illustrate the article.

ERNST A. POHLE, M.D., Ph.D.

**The Effect of the Visible Light, the Infra-red, and Ultra-violet Rays on the Eye.** Wolfgang Hoffmann. *Strahlentherapie*, 1930, XXXIX, 93.

This is a brief review of our present knowledge concerning the effect of light rays on the various parts of the eye. It is stated that the so-called "glass-blower's cataract" is in all probability caused by infra-red rays, although no definite experimental proof has been furnished for this assumption.

ERNST A. POHLE, M.D., Ph.D.

**Erythema Tests with the Vitalux Lamp.** Stephan Epstein. *Strahlentherapie*, 1930, XXXVIII, 372.

In view of the discrepancies in literature concerning the erythema effect of the Vitalux lamp, the author exposed a number of patients to this light under various conditions. He found that a true ultra-violet erythema could be produced in four out of seven cases following an exposure of two hours, at 90 to 100 cm. distance, over an area of 3 cm.  $\times$  4 cm.

ERNST A. POHLE, M.D., Ph.D.

**Cutaneous Papillomata in the Rat Following Exposure to Ultra-violet Light.** G. M. Findlay. *Lancet*, June 7, 1930, CCXVIII, 1229.

Although much attention has been paid to chronic irritation by many substances in the production of cancer, little attention has

been paid to the possibility of carcinogenic action by ultra-violet rays, although there is abundant clinical evidence to suggest that prolonged exposure to sunlight rich in ultra-violet is a cause of skin cancer in man. In Australia, where there is a Northern European population exposed to prolonged and intense sunlight, rodent ulcer and epithelioma of the skin are far commoner than in Great Britain, and, in addition, white cattle in Australia are especially liable to develop epitheliomata, so much so that in Queensland farmers have now abandoned the breeding of white cattle, owing to their liability to develop cancer of the skin. This parallelism of extreme liability to skin cancer in poorly pigmented persons and animals is very striking, and strongly suggests that chronic dermatitis, due to excessive exposure to sunlight rich in ultra-violet, plays a not unimportant part in the etiology of skin cancer both in man and in cattle.

In a previous communication (1928) the author brought forward evidence to show that exposure to the mercury vapor lamp is capable of exciting carcinomatous changes in the skin of a mouse, if these are continued over a period of at least eight months. He now reports similar experiments on albino rats. Six of these animals were used, about six months old, and, after epilations with sodium sulphide, were exposed to the light of a mercury vapor lamp three times a week. Three of these rats were alive eighteen months later and apparently in normal health (nothing is said as to the cause of death of the other three). One month later the author referred to one of the two surviving rats, so that a fourth must have died in that period. At twenty months, a small papilloma was noticed on the dorsal surface of the right ear of this animal, which had, at nineteen months, developed a white opacity in the cornea of the right eye. This papilloma of the ear grew rapidly into a large, horny excrescence. A month later two small ones appeared on the dorsal surface of the left ear. At this period the rat died of bronchopneumonia. Microscopically, the tumor of the right ear had all the appear-

ance of a rapidly growing papilloma, with cell-nest formation and much keratinization; cartilage of the ear was intact. There was no infiltration or metastases, but the author believes that such a rapid growth suggests that infiltration would have occurred had the animal lived longer, and it should also be noted that the growth continued in the absence of further exposures to the lamp. Microscopic study of the eye may have been a sarcomatous condition of the conjunctiva, but it is believed that it was more probably a chronic inflammatory lesion.

H. J. ULLMANN, M.D.

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**Further Studies on the Biological Action of Radiations of Different Wave Lengths.** Ettore Conte. *La Radiologia Medica*, June, 1930, XVII, 689.

The results of these experimental researches seem to contradict the findings of Ludwig and von Ries, who believe in an antagonistic action between ultra-violet and infra-red rays. They may be summarized as follows:

(a) The biological action of ultra-violet rays on experimental rickets of white mice cannot be prevented or retarded by infra-red radiation.

(b) This fact is verified when the radiating energy is administered for either therapeutic or preventive purposes.

(c) Infra-red rays alone may accelerate, within certain limits, the manifestations of rickets in mice fed with Steenbock's diet.

L. MARINELLI.

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**The Principles of a new Ultra-violet Dosimeter.** Edith Weyde. *Strahlentherapie*, 1930, XXXVIII, 378.

An instrument is described for the measuring of the erythema producing part of the ultra-violet spectrum, making use of a light-sensitive solution. When exposed to ultra-violet light, the solution changes to a blue color and discolors again in the dark. It can, therefore, be used for several hundreds of tests. The degree of bluing is determined by a colorimeter whose scale is calibrated in terms of skin erythema. Investigations proved

that the so-called " $I \times T$  law" (Intensity  $\times$  Time) does not hold in this case. It is necessary to add a correction factor which was found to be 0.7 in twelve examined persons. The relation has to be changed, therefore, to  $I \times T^{0.7}$ . The error of measurement amounts to plus or minus 20 per cent.

ERNST A. POHLE, M.D., Ph.D.

**Sources of Radiation and Their Physical Characteristics.** W. W. Coblenz. *Jour. Am. Med. Assn.*, August 9, 1930, XCV, 411.

This supplements a previous paper (June 1, 1929), with data on sources of ultra-violet and infra-red radiation. There seems to be sufficient biologic evidence to show that the effect of ultra-violet radiation is photochemical, and that there is a minimum or threshold value below which this action is ineffective, especially as regards the physiologic action obtained in an exposure of reasonable length.

The tungsten filament lamp, even when enclosed in a bulb that transmits the ultra-violet rays of wave lengths from 280 to 310 millimicrons, emits but little ultra-violet rays of these wave lengths.

The ultra-violet spectrum of the mercury arc consists of a series of intense emission lines irregularly distributed throughout the ultra-violet and visible spectrum.

The incandescent tungsten filament produces a continuous emission spectrum having a high intensity throughout the visible into the infra-red.

A recent production is a combination of a mercury arc between highly incandescent electrodes of tungsten. A tungsten filament operates in parallel with the mercury arc, but it is at a considerably lower temperature than the incandescent tungsten electrodes. The surrounding globe, of special glass, absorbs the rays of wave lengths less than 280 millimicrons not present in sunlight. The mercury arc supplements the ultra-violet radiation at from 280 to 365 millimicrons, which is only feebly emitted by the incandescent tungsten electrodes.

The result of this combination of incandescent solid and arc-vapor radiation is an unusual emission spectrum, consisting of a series

of strong ultra-violet emission lines of mercury vapor superimposed on a continuous spectrum radiation from the incandescent solid, which increases rapidly in intensity and extends throughout the visible and into the deep infra-red.

No data were obtained in the effect of aging of the lamp.

By means of a sensitive sodium in quartz bulb photo-electric cell it was found impossible to measure the ultra-violet rays from a radiant gas heater after provision was made that the burner be over-rated in order that measurements might be procured in normal operation, and also when an excess amount of gas was used. An attempt was made to measure the ultra-violet radiation emitted by the gas flame. Instead of attempting to use the radiant gas heater as an ultra-violet radiator, it should be obvious that such a radiant gas heater is an excellent source of intense infra-red radiation.

Various radiant heaters used for therapeutic purposes do not differ in principle from those used for heating dwellings.

CHARLES G. SUTHERLAND, M.D.

**The Biologic Test of the Ultra-violet Radiation Emitted by a Vitalux Lamp.** Lothar Böhmer. *Strahlentherapie*, 1930, XXXVI, 805.

The Vitalux lamp is constructed like an ordinary incandescent lamp but its bulb is made of ultra-violet transmitting glass. Since some investigators have questioned the ultra-violet emission of this lamp in the region around 3,000 Å., the author exposed fields on the chest and abdomen of patients, at 80 cm. distance, for 90 minutes. In each case, half of the area was covered by glass which did not transmit below 3,300 Å. After 20 hours, a definite erythema appeared on the uncovered area. A photograph of the reaction and also a spectrogram of the Vitalux lamp, unfiltered and filtered through the glass, are appended. The conclusion arrived at is that there is sufficient radiant energy below 3,300 Å. in the emission of the Vitalux lamp to produce an erythema.

ERNST A. POHLE, M.D., Ph.D.

**The Irradiation of Body Cavities by Ultra-violet Light Generated in Them.** Stephan Westmann. *Med. Klinik*, Aug. 1, 1930, XXVI, 1146.

The author describes some instruments designed to bring direct ultra-violet radiation into body cavities. For treatment of laryngeal lesions an endoscope has been devised, with a quartz window on its tip and the mechanism which produces the ultra-violet rays in the endoscope itself. A cystoscope has been constructed similarly. Electrical accidents are avoided by insulation. Spectral analysis shows emission of ultra-violet rays in sufficient amounts to cause a definite reaction. Exposure of limited areas in body cavities is possible with these devices, and may lead to therapeutic results.

H. W. HEFKE, M.D.

**On the Time Factor of the Reaction of Albumin to Radiation.** Wolfgang Gentner and Kurt Schwerin. *Strahlentherapie*, 1930, XXXVII, 788.

The authors continue their experiments concerning the effect of radiation on albumins. In this paper, they report the results of the effect of different intensities of ultra-violet rays on albumin solutions. The latter were exposed in a quartz tube which had been placed in front of the chamber of a dosimeter. The authors found that the time factor is almost equal to one and that only with very high intensities of the radiation employed is there a definite difference in the reaction.

ERNST A. POHLE, M.D., Ph.D.

## WOUNDS (THERAPY)

**The Healing of Operative Wounds in Irradiated Tissues.** Vittorio Podestà. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 446.

The author reports some experiments on rabbits on the healing of wounds, and concludes that large doses of radium delay the

process of cicatrization, and if the doses are very large there is no healing whatever. These doses produce a necrosis of the deeper tissues in direct contact with the radium which does not permit healing to take place until the necrotic tissue has sloughed, and the superficial tissues at the same time show little tendency to close in. As a corollary, the author is of the opinion that in radiosurgery it is best to treat the wounds as lacerated-contused wounds, with great traumatism to the tissues, to wait for sloughing and localization of the process, and then to make a wide excision, followed by suture, through healthy tissue.

The article is supplemented by many photomicrographs and a bibliography.

E. T. LEDDY, M.D.

**The Rate of Healing of Electrosurgical Wounds as Expressed by Tensile Strength.** John D. Ellis. *Jour. Am. Med. Assn.*, Jan. 3, 1931, XCVI, 16.

For the purpose of description of the histologic effects of high frequency cutting currents on tissues, the relative and roughly descriptive terms of cutting, desiccation, and coagulation can be accepted. The use of cutting currents, with just enough desiccation to control capillary hemorrhage without resulting in coagulation and slough, has made justifiable many surgical operations in easily bleeding fields that would formerly have been considered foolhardy. Examples of this are the revolutionizing of brain surgery, partial hepatectomy, and splenectomy for laceration; widespread excisions of facial cancers without subsequent slough, and operations on the jaundiced patient, who is prone to bleed freely from the incisions. The enthusiasm for the new surgical currents has led to some quite optimistic reports regarding uniformly primary healing and rapid cicatrization of electrosurgical incisions.

A study of the tensile strength per centimeter of length, at various time intervals, of healing incisions of skin, muscle, and stomach were performed in dogs. Control scalpel wounds were made. Only 60 per cent of the



electrically produced skin wounds showed primary union in comparison with 97.5 per cent of primary union in the control scalpel wounds, which indicates the futility of expecting primary skin healing in a fair percentage of electrical wounds. When union did occur, the wound was somewhat weaker than in corresponding scalpel wounds, and in the case of heavy dehydration did not attain a strength equal to the scalpel wound in twenty-one days. The stomach and muscle incisions electrically produced show the same percentage of primary union as the scalpel wounds. The electrically produced stomach wounds are notably weaker at about the mid-point of healing. The electrically produced muscle wounds are of almost equal strength with the scalpel wounds through the entire healing period.

While these observations do not argue against the employment of the electrosurgical knife for making surgical incisions when clear-cut indications for its use present themselves,

this method cannot be considered as a practical substitute for the scalpel for routine use.

CHARLES G. SUTHERLAND, M.D.

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#### Studies on the Prophylactic Effect of Irradiation on Inflammations.

On the Influence of Roentgen Rays on the Healing of Wounds. Shuichi Fukase. *Strahlentherapie*, 1930, XXXVI, 95 and 102.

The author studied the effect of roentgen rays upon the healing of skin wounds in rabbits. Two types of radiation were used, 170 K.V., filtered through 3.0 mm. Al or through 0.5 mm. Zn. The dose in both cases amounted to 400 r. It appeared that the heavily filtered irradiation was more effective. The wounds healed much quicker than the untreated parts; there is a true inhibitory action of roentgen rays on the inflammatory reaction in tissue.

ERNST A. POHLE, M.D., Ph.D.

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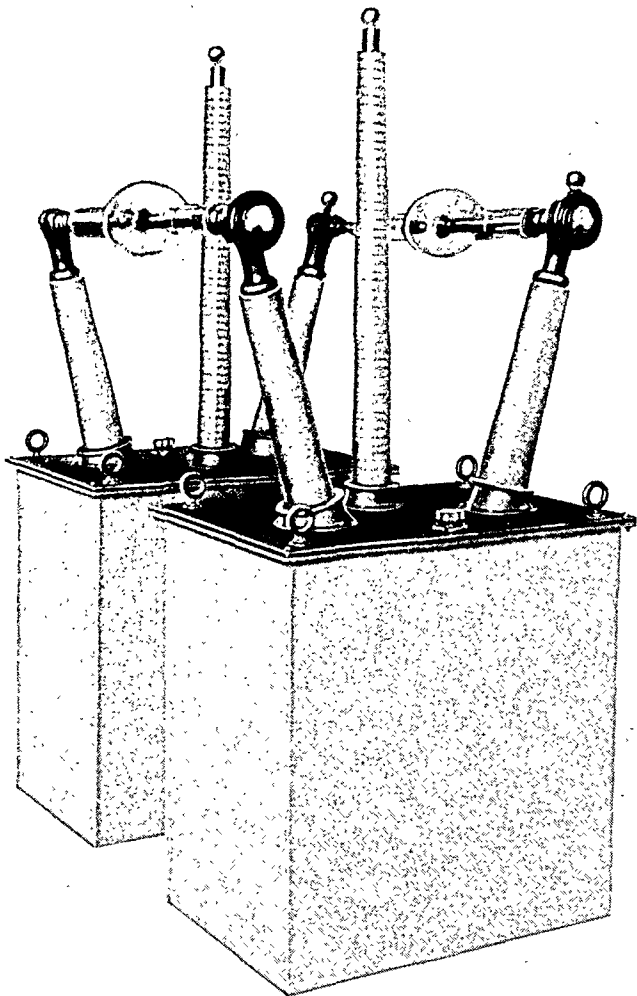
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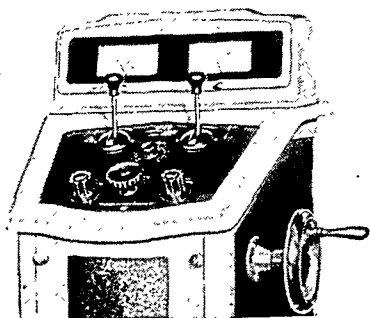
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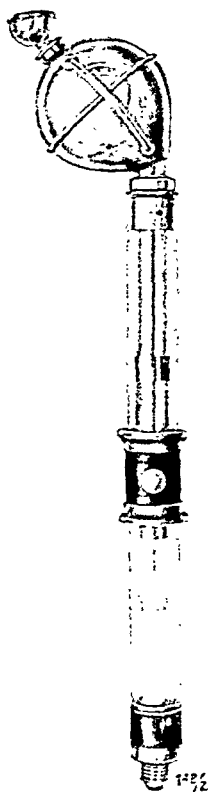
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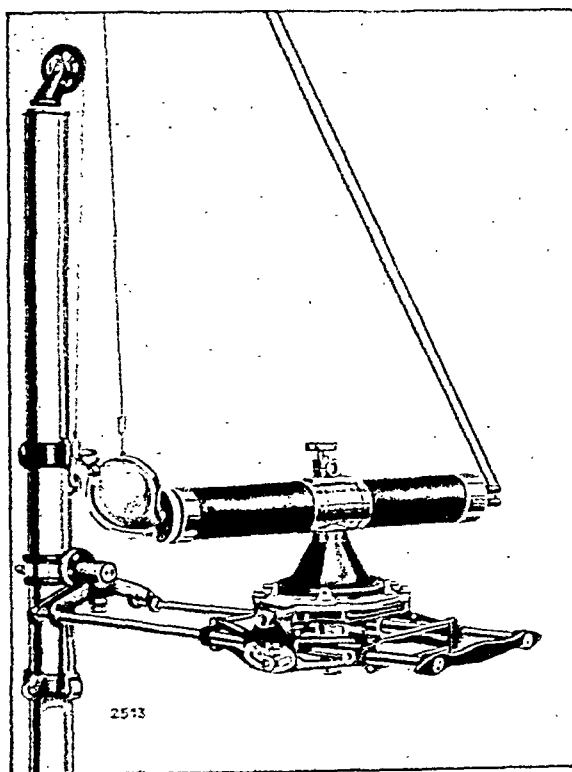
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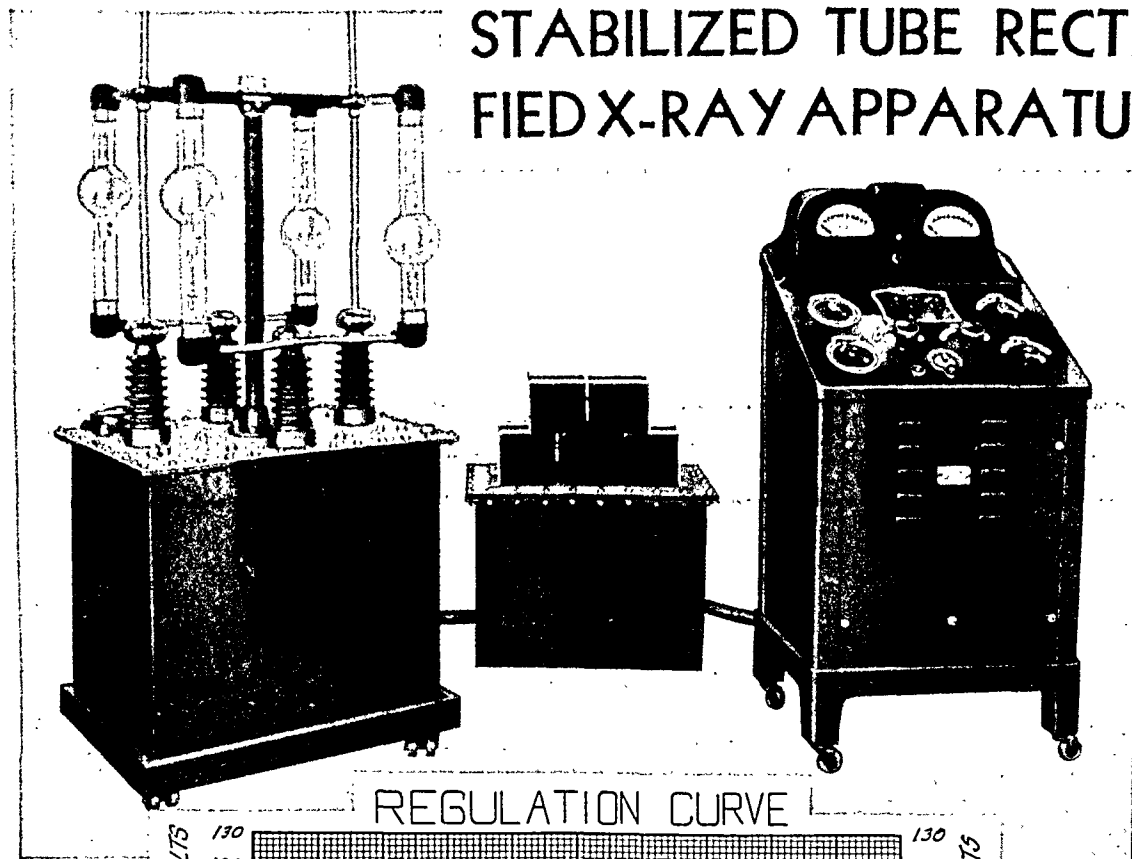


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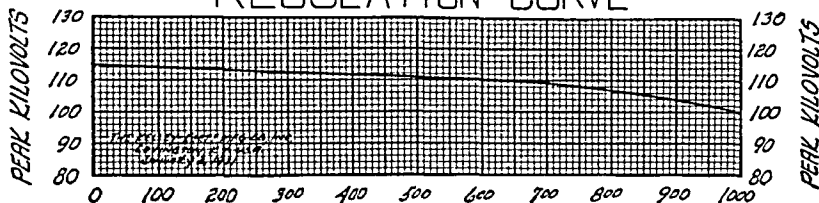
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*Paris, July 26 to 31, 1931*

## Brief Preliminary Sketch of Official Pre-Convention Tour

LEAVE NEW YORK JULY 6TH, 10 P. M., STEAMER FRANCE, first class, arrive Havre July 14. Belgium, Holland, Hamburg, Berlin, Prague, Vienna, Switzerland, Genoa, Monaco, Marseilles, arriving Paris July 26, A. M. Paris in convention to July 31st.

Post convention tour to British Isles or Russia optional (details on request). Societies tour officially ends when convention ends, but every one furnished with ticket back to United States good on any French Line cabin steamer. No attempt is made here to give list of things we do in the above cities and countries except to say we cover everything of interest in the best manner. The ladies will be entertained while the doctors are at clinics.

**THE PRICE INCLUDES** one night at Hotel New Yorker or Hotel Lincoln (no meals) night before sailing, in New York City. Baggage insurance \$300 per person, covering loss, damage, pilferage, etc. Accident insurance \$10,000. (Common carrier.)

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You have nothing whatever to do after you leave the hotel in New York except to go in one of our taxis to the ship. We perform complete courier service. Stops are one and two days, although account of Clinics more interesting in certain cities (for instance, Vienna or Berne) an additional day might be spent. Travel is by ocean liner, train, Rhine river steamer, taxi, DeLuxe autos and in one or two instances short trips are made by motor coach. Special trains if convention is complete 200 persons. All general tipping.

**NOTE:** The Doctors are leaving as an official party on the France, July 6th, taking the Continental tour and Clinics before the Paris convention because Clinic work is much more interesting in July than August (August being a standard vacation month for Physicians in Europe).

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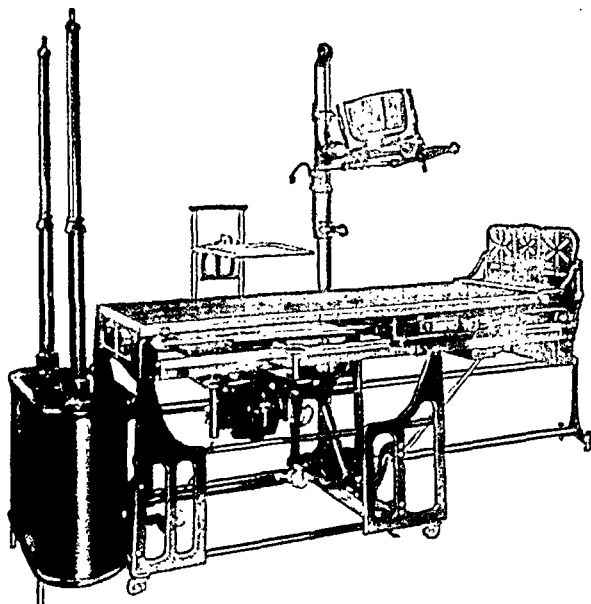
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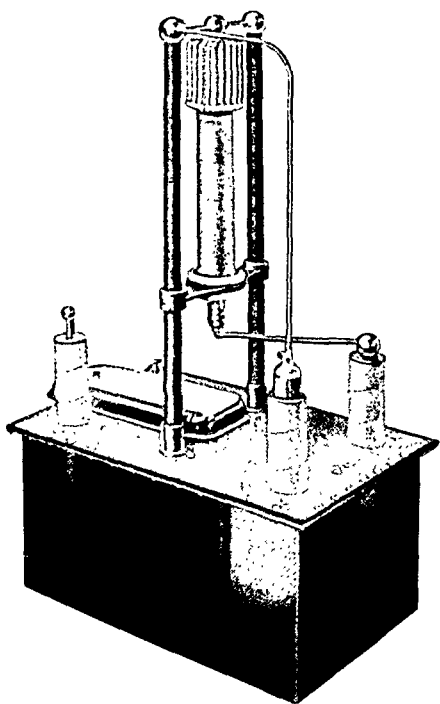
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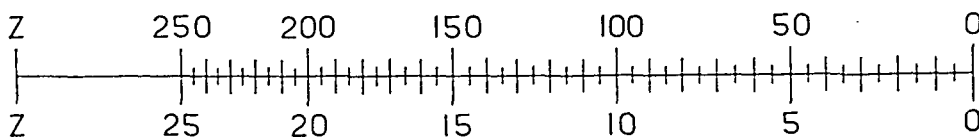
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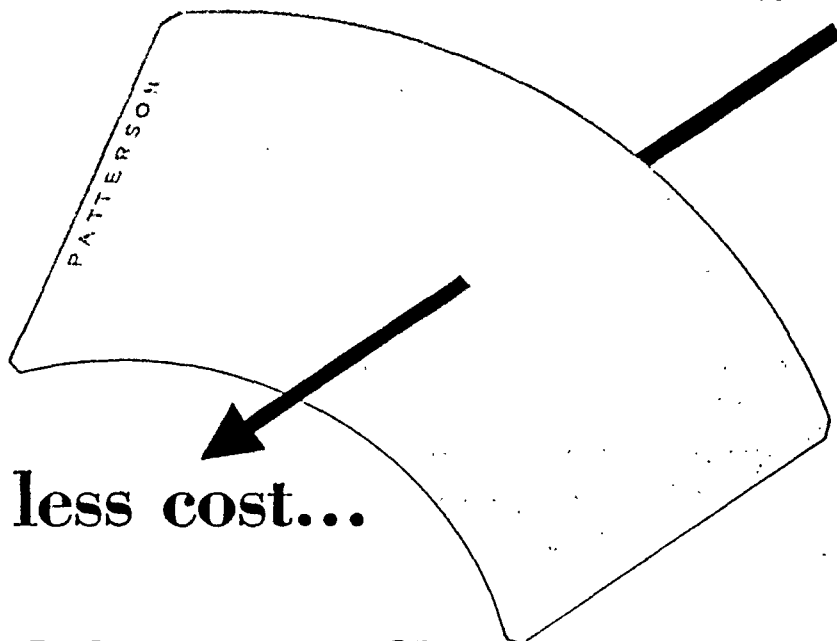
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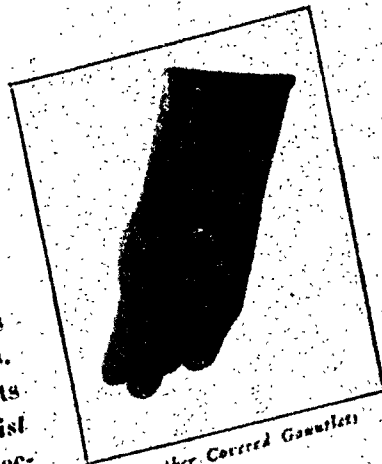
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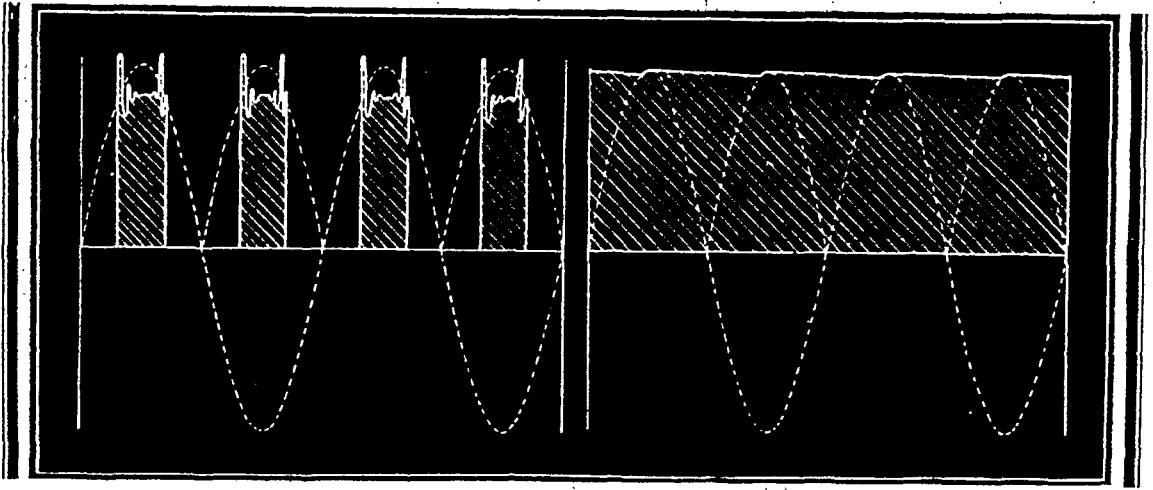


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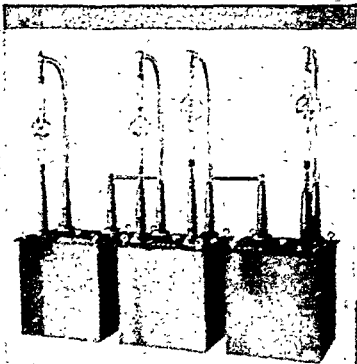
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
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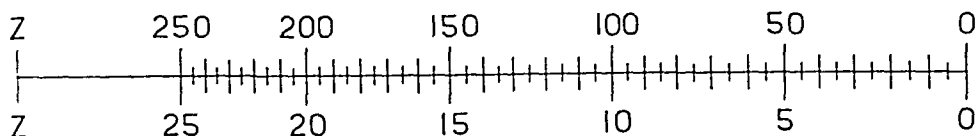
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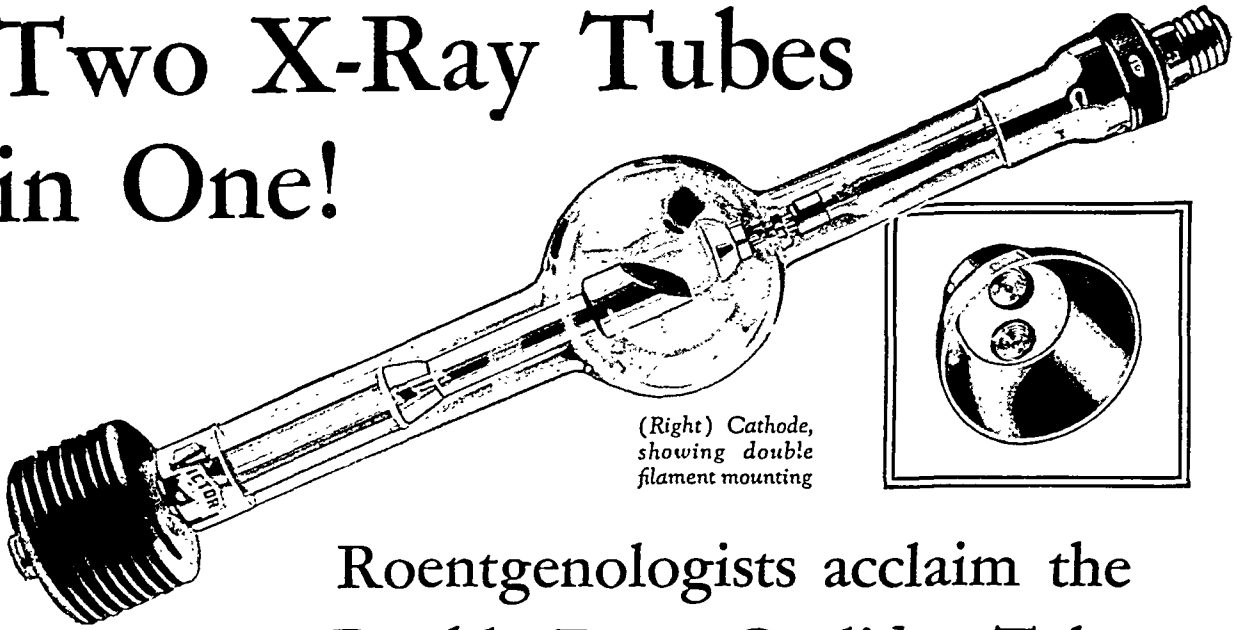
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
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## SKIN MALIGNANCY<sup>1</sup>

### COMMENTS ON THERAPY

By ROLLIN H. STEVENS, M.D., DETROIT, MICHIGAN

THE treatment of malignancy is now a most important specialty embracing several other specialties in general science and in medicine. The treatment of skin malignancies should also presuppose a special knowledge of dermatology.

Up to 1895, surgery, by means of caustics, cautery, or the scalpel, held the undisputed field of therapy in the combat against cancer, which was generally believed to be of local origin. Then radiation entered into the field, and, with it, came an ever increasing accumulation of facts concerning the natural history of neoplasms, and the effects of radiation of various wave lengths, from the hertzian to the gamma field, upon the elements of normal and diseased living tissue.

The result of this thirty-five-year development has been to limit the field of operative surgery in the therapy of malignancies, and especially of skin malignancies, to a very large extent.

Expert application of the new knowledge requires long and special study and training along many different lines, including the physics, chemistry, and biology of rays of all wave lengths, and a good foundation in general medicine, especially in pathology

and roentgen diagnosis. The physician who has not had special training and experience in these branches of science should not undertake to treat malignancies of the skin or other organs. Many, many times ill-advised surgery or insufficient radiation has spelled the death-sentence of credulous patients who could have been saved by expert treatment begun early.

The practice in these days of operating an X-ray machine solely or principally upon knowledge gleaned from the salesman, and of applying radon or radium without proper training in its use, cannot be too strongly condemned and should not be permitted. The public and the profession must be educated to the importance of giving proper recognition to the trained radiologist and specialist in neoplastic diseases.

The therapy of cancer, as of other diseases, depends largely upon its etiology and pathology.

Is cancer a constitutional or a local disease in its beginning?

For many years the answer has been that it is local; hence, removal by surgery was the cure.

But there appears to be more and more of a tendency to regard it at least as an inherited susceptibility and to accept wholly or in part the conclusions of Slye from her

<sup>1</sup>Read before the Radiological Society of North America, at Los Angeles, December, 1930.

classical work on mice. Other possible constitutional factors are being more and more seriously considered.

A degree of immunity of different organs against, or of susceptibility to, certain types or grades of cancer seems to exist. Why is squamous-cell carcinoma the type usually found in the cervix uteri and not in the fundus uteri? And, on the other hand, why is adenocarcinoma almost invariably limited to the fundus? Why is basal-cell carcinoma found in the skin of the face more frequently than the squamous-cell type, while on the back of the hand we find only the squamous cell? Why is a sweat gland carcinoma rarely found, and, when it is, why does it usually involve the face? Why do metastases vary so much in their usual distribution? An adenocarcinoma of the breast, for instance, will frequently metastasize to the lungs, the liver, the vertebræ, the humeri, or the femora, but very rarely to the spleen, or to the bones below the elbows or knees. In bone involvement, in such cases, the metastases must surely be blood-borne, and, if so, why is there apparently selective involvement? The cancer cells or virus must be distributed everywhere. Can we explain distribution of metastases entirely upon an anatomical or a physiological basis? If so, how explain the early and almost certain metastasis from a Grade 3 or 4 squamous-cell carcinoma of the cervix and a very delayed and uncertain metastasis from a Grade 1 or 2 squamous carcinoma of the same region? Why does not a basal-cell carcinoma of the skin metastasize and why does a squamous cell always metastasize? Why does a melanoma metastasize so much more rapidly and diffusely than a squamous cell of the skin? Evidently grade of differentiation and type of cell play rôles in metastasis that are independent of the anatomy of the parts involved. May we not say that certain organs and tissues of the body possibly carry within their cells a certain susceptibility, probably inherited, for cer-

tain neoplasms, just as certain organs and tissues exhibit great susceptibility for the action of certain drugs?

These considerations must be borne in mind when we are treating carcinoma. We make a five- or ten-year "cure," then a neoplasm appears in the treated field or in some other field. Has a cancer cell lain dormant all these years, or is it a sudden mutation of a cell which carried within itself a something, a susceptibility, to change into a life of malignant riotry? If so, we must do something more than surgery or radiation to prevent the handing down of the disease to posterity. The generation involved must not reproduce, or, according to Slye, it must be bred out with immune individuals for two generations.

But the present religious, moral, and social attitude of the race forbids anything of this kind. To gain a knowledge of heredity in the human would mean the education of the people to the necessity for periodical health and general postmortem examinations, and the control of reproduction. This, of course, is not likely to take place for several generations yet, though there is already much sentiment for birth-control, which, if intelligently carried out, would be in the right direction of progress in cancer control.

There are certain conditions which seem to contain within themselves elements which finally lead to cancer. Xeroderma pigmentosa which appears after the first exposure to sunlight is one of these conditions. The sunlight seems to be a specific irritant or stimulant for assisting in the development of this disease. The susceptibility of the cells is probably hereditary. The sun's rays simply activate the chemical action which changes the susceptibility to an actual malignant change. "Farmer's" or "sailor's skin," with malignant change, develops after long and frequent exposures to the sun's rays. Cancers of the skin also develop after long and constant exposure to certain tars, oils,

and soots. These malignancies are said to be due to chronic irritation, which for many years has been considered as a cause of cancer. Arsenical dermatoses leading to malignancy are similar. Is it not possible that these are *specific* irritations which finally result in cancer in individuals who carry susceptible cells? Be it noted that long exposures to these agents do not always cause cancer. Chronic irritations of a general character do not always lead to cancer, by any means. May not the development of these cancers be ascribed to inherited susceptibility, hastened by specific agents which develop within the cell a chemical or electrical change which is sufficient to overbalance the susceptibility and develop cancer as we know it?

The diagnosis of malignancy of the skin is generally not very difficult, if one checks it with a properly made biopsy studied by an expert pathologist. Without this, many serious mistakes are made, especially by the inexperienced, as well as occasionally by the experienced. When we consider that mistakes of this kind are not easily, if at all, corrected, one must realize the importance of biopsy and expert diagnosis of skin lesions before undertaking any form of treatment.

Lupus vulgaris and erythematosus and tuberculous adenomas, blastomycosis, moles and nevi of various types, sarcoids and morphea, primary or tertiary (gummatous) forms of syphilis and granuloma pyogenicum (especially on the lower lip), sebaceous cysts, keloids, neurofibromas, seborrheic, senile, or actinic keratoses, fatty tumors—all these are often misdiagnosed as malignancies. Not infrequently malignancy develops in a lupus of the skin or a gumma of the tongue, or in a mole or other nevus, keratosis, scar, etc., and must be recognized and receive proper treatment. The first requisite in the treatment of cancer is as thoroughly correct a diagnosis as possible.

The clinical appearance of melanotic growths, together with the very great danger of biopsy or operative interference with the cold knife, must be appreciated. Indeed, we would advise the same caution in connection with any non-pigmented mole or nevus. Such a one often contains metastatic melanotic possibilities not apparent upon microscopic study.

#### BIOPSY

There is an honest difference of opinion about the safety of biopsies in cancer. For statistical purposes, a pre-operative biopsy is essential, but it must be of sufficient area to represent fairly the characteristics of the tumor and its growing border. The French school, headed by Regaud, insists upon a biopsy in every case before applying radium, not alone for statistical purposes, but especially to determine the type and grade and to learn something about the radiosensitivity of the tumor, so that radiation may be applied more intelligently. Most other cancer centers practise biopsy at least for diagnostic purposes. Many radiotherapists advise against it. It has been shown by Wood and others how easy it is to squeeze cancer cells out of the tumor into lymph spaces. It is probable, too, that local anesthetics, injected to relieve the pain of a biopsy, may be the means of forcing cancer cells into the circulation. Personally, we have never had proof of causing metastasis by biopsy, but we have seen many metastatic sequences after operative interference in moles by the cold scalpel. We have not seen metastases follow their removal by surgical diathermy except in one case of melanotic cancer, which recently came under our care. A woman fifty years of age had a black pigmented mole on her temple, which started to grow. She consulted a physician, who destroyed it by desiccation. Three weeks after, when the wound was healed, a second growth appeared alongside



the scar. The patient was then referred to a surgeon, who removed the growth with the radio-knife. Another nodule developed near the scar and one in the eyelid, and she was referred to us. We applied a large radium pack, filtered through 1.5 mm. of platinum and 2 cm. of wax and sawdust, over a large part of the same side of the face and scalp for five days. The tumors disappeared, but three months later another appeared on her leg, and rapidly involved the whole skin and the internal organs. It is probable the original lesion was not treated widely enough, or that the anesthetic was injected too close to the growth. We judge this from the fact that the first secondary growths appeared in the near neighborhood of the primary lesion. No more appeared there after the thorough radium treatment (which, by the way, indicated a sensitivity to radium which is denied by some radiologists to-day).

It has been shown that particles of melanin extend quite a distance in the skin beyond the melanotic growths and rather deeply below the surface, so that these growths would better be treated with radium packs before or after removal, and the surgical diathermy should be of wide and deep extent. This can be done with radio-knife and provide a good specimen for microscopic examination.

In the malignant lymphomas, biopsy is frequently required. Inasmuch as these tumors are probably of lymphocytic origin, and are more or less constitutional, surgical interference with the cold scalpel for biopsy purposes probably makes no difference in the outcome of the disease. The biopsy should be made in practically all cases if the tumor is easily accessible.

#### TREATMENT

The principal methods of treatment in vogue in the last thirty years include the following:

(1) Caustics, such as pyrogallie acid, arsenious acid, zinc chloride, potassium hydrate, freezing with carbonic snow, Sherwell's acid nitrate of mercury treatment after curetting, etc.

(2) Intravenous injections of glandular extracts, serums, toxins, vaccines (Doyen), dyes and other chemicals such as lead, gold, bismuth, etc.

(3) Surgery—by means of the cold knife wide excision, by the radio-knife, fulguration, desiccation, electrocoagulation, actual cautery.

(4) Radiation by X-ray, mesothorium, or radium.

#### CAUSTICS

Caustics of various kinds in the form of pastes, applied without preliminary operative interference such as curettage, have seldom been used during the last few years, except by the quack and illegal practitioners, who continue to attract the credulous and unsophisticated public by their alluring advertising and propaganda.

This treatment could be quite effectual in basal-cell types of growths which do not metastasize, but might be worse than useless in the much more malignant metastasizing squamous-cell, nevo-, or melanotic carcinomas. Likewise, in any of the sarcomas and malignant lymphomas it would be wholly ineffectual. The disadvantages of chemical caustics are: (1) that their action below the surface cannot be very accurately observed or controlled; (2) that they destroy all tissue, pathologic as well as normal, with which they come in contact; (3) that they exercise no influence in involved, but apparently normal, tissue, outside their field of caustic action; (4) that their action is marked by long-continued pain. The action of carbonic snow is too superficial anyway to be considered as an effective agent in any malignancy. With our present-day knowledge of cancer and

effectual means of combating it, we believe caustics should have no place in the armamentarium in the fight against malignant diseases of the skin.

INTRAVENOUS INJECTIONS OF GLANDULAR  
EXTRACTS, SERUMS, TOXINS, VACCINES  
(DOYEN), LEAD, GOLD, BISMUTH,  
AND DYES

For many years all of these agents have been tried in one form or another in cancer, and while occasional more or less reliable reports have been published regarding Coley's toxins and the Blair Bell lead treatment, no authentic reports of cures have been made concerning any of the other agents.

Efforts are being made to find an organ tissue, a dye, or other chemical which may be taken up by the living cancer cell and which will break down its resistance, but as yet there has been no success in this line of research. It is possible that something may be found, which, when injected, may so sensitize or lower the resistance of a radio-resistant cancer that the latter may yield to roentgen or gamma radiation, especially if we can use it in much higher voltage and in much larger quantity of energy, as seems well within the range of possibilities.

SHOULD SURGERY BE EMPLOYED FOR CURE OF  
MALIGNANT GROWTHS OF THE SKIN?

The surgeon for so many generations has claimed this field as his, that it is difficult for him to recognize and yield to a competitor. He has removed and cured permanently many malignancies of the skin, especially of the basal-cell type which are local and consequently more or less benign. With the squamous-cell group and the melanomas he has not been so successful, while the expert radiologist has had real success. The radiologist claims better cosmetic results and is able to combat metastasis quite effectually, in which the surgeon is not successful.

When the metastasis involves the glands of the neck, it is still an open question whether the radiologist or the surgeon has the better success. Certainly the loss of muscular function and the unyielding scar tissue, after such extensive and serious operations on the neck, together with such uncertain final results, produce a picture of convalescence which is to be avoided if possible. The successful results sometimes secured from the heavily filtered radium pack about the glands of the neck are much more pleasing. Improvement in radiation equipment and technic may raise the percentage of cures in such cases.

There is no question but that a growth in the skin itself can be removed by radium or X-ray much more surely and safely and with better cosmetic results than by surgery. In some cases, such, for instance, as those involving the cartilage of the ear or nose, and in some cases of the mouth, better results may be obtained by surgical diathermy—in which latter term we include the radio-knife. If the growth is very small, we use the radio-loop or radio-knife for immediate removal of the whole growth. In growths about the eyelid, Eller highly recommends the super-soft rays (8,000–10,000 volts). We have not had enough experience with these rays in malignant conditions to advise. In melanomas, many—but not all—of which are quite radioresistant, wide and deep removal by radio-knife, together with radium or X-ray, is indicated. Most of this work is done under local anesthesia. In that case, we believe one must be careful to use a block or modified block anesthesia and not inject the fluid into, or very close to, the lesion, for fear of carrying malignant cells into the circulation.

We have found arsenical carcinomas peculiarly resistant to radiation, and surgical diathermy may, by preference, be used in many of these cases if the growths are not too extensively distributed. The

Bowen type, while often quite resistant, usually responds to adequate radiation, as does also the extra-mammary Paget's disease.

We have had one case of adenocarcinoma of the face, of sweat-gland origin—a rare lesion—which was exceedingly radioresistant, and we believe it should have been treated by surgical diathermy at first. It had been diagnosed and operated upon in Scotland as tuberculous a few years before.

We are of the opinion that when the clinical examination and the biopsy show a highly radioresistant type of malignancy in the skin, the lesion would better be removed by surgical diathermy, but not by the cold scalpel. We believe the former method to be safer than the latter. The cells will not be distributed in the circulation or in the wound, at any rate, by a hot knife.

#### RADIATION TREATMENT OF CANCER

Our knowledge of the cause and cure of cancer is still in a condition of flux, and it will probably be many years before the truth concerning the origin and elimination of this disease can be crystallized out of the heterogeneous mass of information that is now being accumulated and will continue to be accumulated in the future. The literature upon this subject during the last few years has been tremendous, and is sufficient to occupy the entire attention of anyone interested. We may be a long way from our goal, but we have gathered together a great mass of data relating to malignancy with which we must familiarize ourselves if we are going honestly and conscientiously to undertake to treat any case of cancer. No conscientious doctor, knowing what is being done to relieve the unfortunate sufferer from this dreadful disease, will lend himself to a scheme to attract patients suffering from cancer by heralding a "cure" which has been untried. It is nothing short of criminal to use one's position and money to

entice suffering and dying persons to come—perhaps from long distances—for a treatment which has little or no evidence behind it to warrant its being used at all. A cure for cancer, if there ever is such a thing as a cure—it is much more likely that there will be *cures* rather than *a* cure—will not be announced out of a clear sky. It will take long and patient experimentation to develop and prove up anything that is going to be of value in the treatment of cancer. Such experimentation has been carried out with X-ray and radium in the treatment of cancer during a period of from thirty to thirty-five years. Innumerable facts of both positive and negative value have been discovered during these years, and now we can truthfully and honestly say, from extensive statistics gathered in many different clinics in different countries, that X-ray, radium, and surgical diathermy offer more hope and encouragement for cancer of the skin than any other treatment known to-day.

Rare, indeed, is the case of cancer of the skin—not too far advanced—which cannot be cured to-day by the expert with the use of X-ray, radium, or surgical diathermy. The great difficulty lies not in the fact that man cannot secure these expensive agents, but rather in his lack of knowledge and experience properly to apply them. It would seem that the time is almost here when the doctor who wishes to treat cancer and who wishes to use such agents as X-ray, radium, and diathermy, will be required to pass a special examination before being permitted to practise in that special field. The ophthalmologists require a special examination before a doctor can become a member of their scientific organization, so technical and specialized is their work regarded: surely it is not any more so than the work of the radiologist and the cancerologist.

For a number of years, statistics have shown that from 85 to 95 per cent of the cases of cancer of the skin may be cured

by X-ray or radium. Of course, those statistics are not accurate, because so much depends upon the type and grade of cancer, as well as upon the stage of its existence, as to what may be accomplished. Whether or not there are such things as pre-cancerous diseases, which may not be the proper term to use, there are certain lesions which are very closely associated with or followed by cancer, as we know it, and which, if removed early in the proper way, will, no doubt, prevent development of the disease, at least at the site of removal. If the disease, whether highly malignant or not—like a squamous-cell carcinoma or a melanoma—is treated early and by proper methods, the percentage of cures should approach close to 100 per cent.

#### SO-CALLED PRE-CANCEROUS LESIONS

*Keratosis.*—These are seborrheic, senile, actinic, or arsenical in origin. If they are accompanied by any irritation of the surrounding or underlying skin, we advise their removal. We generally use X-ray or radium for this purpose—the unfiltered X-ray or the beta and gamma rays of radium. If there is a suspicion of malignancy already developing, and the lesion is less than 2 cm. in diameter, we give a hypermassive dose of unfiltered X-ray, followed by filtered X-ray, every day or two to the area about the lesion, keeping the dose up to saturation for a couple of weeks. Radium can be used similarly without enough filter to stop the beta rays. Arsenical keratoses are often highly resistant to radiation. It is better to use desiccation in these cases. Indeed, desiccation is often the agent of choice in any of the keratoses, whether or not they are becoming malignant. Especially if they have had previous insufficient radiation and have recurred, we think this might be the method of choice.

*Moles.*—We do not hesitate to advise the removal of moles when they are of the type

which projects above the surface, especially when so located that they are subjected to irritation, or if they contain melanotic pigment; but we would caution against removal of such moles with the cold knife, curet, or caustic. We have seen many cases of fatal metastatic melanoma following removal of moles by excision with the knife. We have never, among thousands of cases, seen such a catastrophe follow removal of moles by thorough electrolysis, desiccation, or radio-knife or radio-loop in our own practice. We have seen one such catastrophe follow from a mole of the face which showed irritation for several weeks, but which the patient declined to have removed. Of course, we must bear in mind, as in this case, that malignancies in moles and other nevi may already be microscopically metastatic before any kind of treatment is carried out. Such metastasis may not be discovered until a later development, and perhaps we are not warranted in condemning the use of the cold knife, since in the cases we have observed metastasis might have been present before the operation. However, it is reasonable to suppose that there will be less chance of inoculating the tissue with cancer cells which we cut through with a hot needle, loop, or knife, than with cold instruments. In melanomas, it is our practice, and we believe it is good, to treat a large area about the growth removed with well-filtered X-ray or gamma ray by the saturation method. Melanomas are said to be highly resistant to these rays, a fact which we have found to be true in some, but by no means all, cases, for we have seen metastatic melanomas melt away under roentgen or gamma rays and not recur in the same locality. Therefore, we believe heavy, well-filtered radiation should be given all these melanotic cases and continued daily to saturation for three weeks. Inasmuch as these metastases are blood-borne, we doubt the efficacy of treating the drainage glands, though we often do

it as a precautionary measure. Our practice with all moles is to remove them widely and deeply with the radio-loop or radio-knife, and send the specimen to the laboratory immediately. If we suspect the mole of malignancy before we get the histologic report, or if the latter is positive, we begin radiation treatment at once. If not, we dress the wound daily till it heals, and give no radiation.

# CLASSIFICATION OF MALIGNANCIES OF THE SKIN

Malignancies of the skin may be classified as follows:

Basal-cell carcinoma or so-called rodent ulcer  
Squamous-cell carcinoma  
Mixed-cell carcinoma  
Spinous-cell carcinoma  
Adenocarcinoma  
Bowen's disease  
Paget's disease (extra-mammary)  
Nevo-carcinoma  
Xeroderma pigmentosum  
Arsenical cancer  
Melanoma  
Spindle-cell sarcoma  
Round-cell sarcoma  
Kaposi's multiple pigmented hemorrhagic sarcoma

## BASAL-CELL CARCINOMA

Inasmuch as the basal-cell carcinoma does not metastasize, at least not in its early stage, it is not regarded as very malignant and is generally cured with ease by various surgical or radiological means before it becomes very extensive. The Sherwell method, *i.e.*, by curettage and application of acid nitrate of mercury, is in favor with some dermatologists. However, we must remember that basal-cell growths often arise from more than one center, that they are sometimes of mixed-cell composition, and so may be of metastatic character. Furthermore, the cosmetic results of such treatment

are not so good as by radiation, and the scar tissue resulting will have diminished resistance to cancer cells. Therefore, we claim that thorough radiation of these growths is the method of choice. They may be removed intact by the radio-knife or radio-loop so that their structure is preserved for microscopic examination. Radiation treatment later would depend upon the degree of malignancy found. Their removal should be as complete as possible in the first instance, because, aside from the fact that with insufficient treatment they—as well as other types of malignancy—gain resistance to radiation after insufficient treatment, their increased growth and extension may be very destructive to important organs, especially when they are located near the orbit, the nose, or the ear. The growth may extend into the cartilages and bones, finally destroying them. Oftentimes the entire nose, with its adjoining osseous structures, or the entire orbit, with its contents, or the entire ear are thus destroyed without evidence of metastasis. Basal-cell growths occur most frequently in the face. If these growths are treated by X-ray or radium by hypermassive unfiltered doses, or by X-ray or radium followed by adequate highly filtered doses to the same area and a large area about it, such results can be prevented.

## METASTASIZING CARCINOMAS

Squamous-, mixed-, and spinous-cell carcinoma, being highly malignant, with a strong tendency to metastasize to the neighboring drainage glands, where they are inaccessible to treatment, will be considered together. They may, for practical purposes, be classed in one group. If the growth is small, it would better be widely removed by radio-knife for microscopical examination. If it is of fairly large size, a section will be sufficient. The wound should receive some electrocoagulation or desiccation in addi-

tion; then radiation should be begun. Inasmuch as these growths often metastasize very early, a large area about the growth, as well as the drainage glands, should be treated by cyto-elective radiation, *i.e.*, by highly filtered rays, at a considerable distance to get the maximum amount of energy at the required depth consistent with the toleration of the skin. This can no doubt be accomplished best with the shorter, more homogeneous wave lengths, such as we get from high voltage, highly filtered X-rays or highly filtered gamma rays. Within certain limits, at any rate, the shorter and more homogeneous the wave length, the better is the skin conserved, and the greater is the depth dose. Hence, we prefer to treat these cases with the highest voltage at present obtainable (said to be 200 K.V., but probably not more than 160 to 170 K.V. in the general run of practice, because the present American tubes will not stand up under greater strain). For this reason, we prefer radium, and follow as closely as possible the Regaud technic. We often give both X-ray and radium, as with this combination we can increase our radiation 30 per cent over what the skin would ordinarily tolerate under the action of one of these agents alone. The difficulty with X-ray is to get a sufficiently short wave length. We have in the X-ray an abundant amount of energy, but lack quality. With radium it is the reverse, so that on account of the inverse square law we must shorten our distance in order to convey into the depth as large an amount of energy as possible, but we are greatly limited here because the skin is necessarily so close to the source of radiation that it suffers disproportionately from a much smaller amount of energy than that which we convey by deep X-ray at a much greater distance, distance being a very important factor.

If we apply a pack of, say, 4 grams of radium at, say, 10 cm. distance, according

to the inverse square law we should have to employ twenty-five times as much radium, namely, 100 grams, to convey the same amount of energy into the tissues if we wish to treat at 50 cm.—the usual deep X-ray therapy distance. This, of course, is not practical at the present time. When we use deep X-ray therapy we follow the Kingery law, as put into practical use by Pfahler, and keep the tissues under saturation for three weeks. If we use radium according to the Regaud method, we continue the application for from five days to two weeks, according to the amount of radium available, the depth of our dosage, and the practical distance at which we may use it. By this method we have been able to make an occasional five-year cure of metastatic squamous-cell carcinoma of the neck.

The only alternative is a block dissection of the neck, which is a serious operation, resulting in much limitation of the movements of the neck and by no means successful in curing metastatic cancer in a great majority of cases. We believe that the best success in these cases will finally come from intensive short wave therapy (at least 500 or 600 K.V.) at a considerable distance—about 50 centimeters. The primary squamous-cell growth in these cases, whether on the lip or some other part of the face, can usually be cured by the X-ray or the radium facilities we have at hand.

#### BOWEN'S DISEASE

The Bowen type of carcinoma is usually quite resistant to radiation but subsides under skillful treatment with X-ray or radium, with or without surgical diathermy. The same may be said of extra-mammary Paget's disease. In the mammary Paget's we have a carcinoma of the breast to deal with and we believe pre-operative intensive and prolonged deep X-ray treatment should be given.

Sarcoma cutis of the round-cell type is more radiosensitive than that of the spindle- or mixed-cell type. These tumors should be treated by deep therapy, X-ray, or radium, and kept up to saturation for two or three weeks.

The multiple pigmented hemorrhagic sarcoma as described by Kaposi is quite radiosensitive, and should be treated by moderately high voltage X-ray, well filtered in moderate doses, repeated as development of the disease demands. Comparatively small doses will cause lesions to disappear. Care should be taken to preserve the normal skin. A permanent cure will probably not be made.

The same may be said of the lymphoblastoma group, but they require different amounts of treatment. Hodgkin's type of malignant blastoma usually requires a larger amount of radiation than the myelogenous or lymphatic leukemias. In all this group, the more homogeneous hard filtered ray is advisable.

We believe we have seen beneficial results in some of these cases from injections of from 50 to 200 microcuries of radium chloride following X-ray.

#### SUMMARY

There is great need for expert specialism in radiological treatment of neoplastic dis-

eases. Special courses and examinations should be requisite for one to practise in these specialties. Local cures of cancer of the skin by modern expert radiation management should approach closely to 100 per cent.

The great importance of biopsy for diagnostic and selective treatment purposes is emphasized. Biopsies are perhaps much more safely performed by means of the radio-knife than by the cold knife. We judge this is especially true in treating melanomas and moles.

The relative values of surgery and radiation in the treatment of malignancies of the skin are discussed, and radiation and electric surgery appear to be of greater value in the treatment of skin malignancies than surgery by the cold knife.

Modern research appears to show rather conclusively that there exists in the cancerous individual a susceptibility of certain cells under some conditions to undergo change to malignant riotry. While radiation or surgery may cure the local condition, the patient is in all probability a carrier of the cancerous tendency to later generations, and so the disease in the race may be stamped out only by breeding it out, as suggested by Slye. This would entail, however, generations of careful ante- and post-mortem examinations.

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# STUDIES OF THE EFFECT OF ROENTGEN RAYS ON THE HEALING OF WOUNDS<sup>1</sup>

## I. THE BEHAVIOR OF SKIN WOUNDS IN RATS UNDER PRE- OR POST-OPERATIVE IRRADIATION

By ERNST A. POHLE, M.D., PH.D., Professor of Radiology; GORTON RITCHIE, M.D., Instructor in Pathology, and CECIL S. WRIGHT, M.D., Senior Resident in Radiology, University of Wisconsin Medical School, MADISON, WISCONSIN

THE question of the effect of roentgen rays on the healing of wounds is a problem of ever-increasing interest to both the surgeon and the radiologist. A study of the literature discloses a variance of opinion on this subject. It also reveals, however, a scarcity of carefully controlled experiments arranged so as to permit certain comparisons with clinical problems. We feel, therefore, that a discussion of a few selected articles from the recent literature should suffice.<sup>2</sup>

In 1928, Frey (1) exposed the extremities of dogs to filtered roentgen rays of short wave length as used in deep therapy. One group received one erythema dose every four weeks, six times; a second group received one erythema dose every six weeks, four times; a third group received one erythema dose every eight weeks, three times, and the last group received one erythema dose every twelve weeks, twice. The other extremity served as control. Four weeks following the last exposure, the animals were killed and the arteries injected with a contrast medium (minium). Roentgenograms were then taken of the entire extremity and frozen cross-sections made in order to demonstrate the blood-vessel distribution macroscopically. Groups 1 and 2 showed definite blood-vessel injuries, Group 2 less than Group 1. In Group 3 there were only slight changes, and in Group 4 no deviation from the normal could be detected. The lumen of the ves-

sels was narrowed and their number definitely decreased. It appeared that the degree of injury was directly proportional to the total dose applied in a given period; the shorter the interval between the treatments, the greater were the pathologic changes. In another series of experiments the same author tried to determine the time required for the manifestation of the blood-vessel injuries. He exposed one kidney in dogs with 150 per cent E.D., and killed the animals one, two, and three months, respectively, following the treatment. The vessels were visualized by the injection of a contrast medium. After one- and two-month intervals, no macroscopic changes could be seen; the blood vessels of the irradiated kidney appeared to be the same as those of the untreated control. In the animals killed three months after treatment, there were also no macroscopic changes, but following injection it appeared that the number of blood vessels was definitely decreased, particularly in the medulla and the cortex. Frey concludes from these observations that within eight weeks following pre-operative roentgen therapy the surgeon should not encounter any difficulties; there should particularly not be any delay in healing. Since he did not work on wounds, however, his conclusions rest entirely on the supposition that no functional change precedes the actual morphological changes in the vessels.

More recently, Fukase (2) has approached the problem from another angle. He studied the influence of roentgen rays in moderate doses (350 r) on the healing of a simple skin wound in rabbits. From his

<sup>1</sup>Presented before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

<sup>2</sup>Bibliographies covering the older literature will be found in the papers of Frey (1).



experiments, it seemed that heavily filtered roentgen rays (170 K.V., 0.5 mm. Zn), if given in this dose over a fresh cut through the epidermis down to the cutis, decreased the inflammatory process following the

ical explanation is seen in the inhibitory effect of roentgen rays on leukocytes with oxyphile granules.

The fact that the researches of Frey were limited to the effect of fairly high doses of

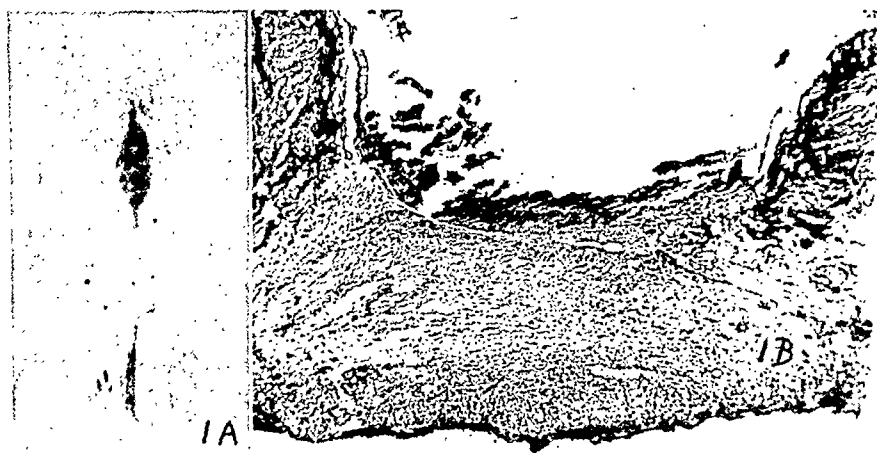


Fig. 1. Rat K 1; 100 K.V., 2.0 mm. Al, 1,000 r. One-day E-C interval. Fig. 1-A. Wounds seven days following the incision. Fig. 1-B. Photomicrogram of irradiated part of the cut.

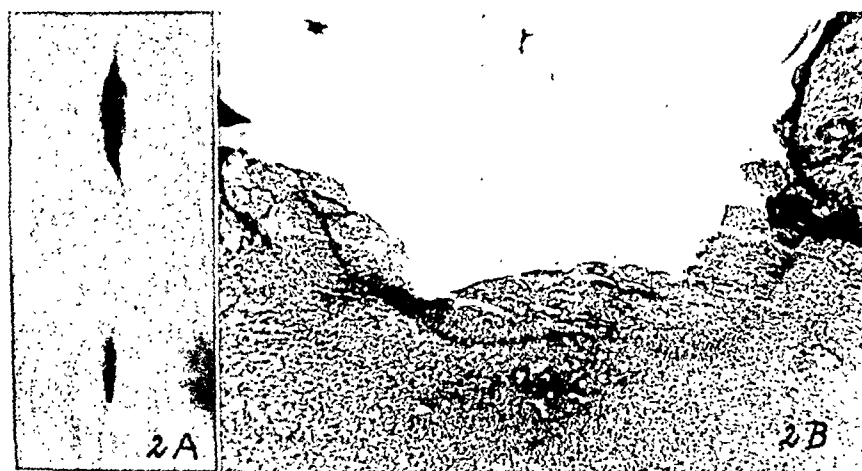


Fig. 2. Rat J 1; 100 K.V., 2.0 mm. Al, 1,000 r. Three-day E-C interval. Fig. 2-A. Wounds seven days following the incision. Fig. 2-B. Photomicrogram of irradiated part of the cut.

trauma; in other words, the irradiated part of the wound healed more quickly than the unexposed control. Less filtered radiation (3.0 mm. Al) at the same potential had hardly any effect. The pathologic anatom-

ical explanation is seen in the inhibitory effect of roentgen rays on the blood vessels only, and that Fukase dealt with doses below those used in malignancies, as, for instance, in pre-operative irradiation of a breast carcinoma, we decided to start a systematic



Fig. 3. Rat D 1; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval. Fig. 3-A. Wounds seven days following the incision. Fig. 3-B. Photomicrogram of the irradiated part of the cut. Fig. 3-C. Photomicrogram of the unirradiated part of the cut.

study of the entire problem. Since a large number of tests seemed to be one of the most essential points in such an investigation, rats were selected for the experiments because they were most available and easily cared for. Furthermore, the toleration of their skin to roentgen rays was well known to us through previous work (3, 4). In this first paper, we have studied the behavior of dorsal skin wounds produced at certain intervals preceding exposure and also following exposure to roentgen rays.

#### METHOD

Adult white rats of the same strain and free from skin lesions were kept in metal cages on a standard rat diet. Before exposure or cutting, the hair was removed from the back in an area of approximately  $8 \times 2$  sq. cm., by clipping, in order to avoid the irritation of shaving. The cuts reached to the external fascia of the dorsal muscles and had an average length of 2 cm. in the case of pre-operative irradiation and of 6 cm.<sup>3</sup> in the rats irradiated following operation. From here on, the procedure differed in the animals treated before (First group) and after (Second group) operation.

<sup>3</sup>It was necessary to place one Michel clip in the center of the cut in order to prevent extensive gaping. Before cutting, the skin was painted with a 2 per cent mercurochrome solution.

In the first group, two fields of  $1 \times 1.5$  sq. cm., with 2 cm. of intervening normal skin, were exposed. The cuts were made 1, 3, 7, 10, 14, 21, and 30 days, respectively, following the X-ray treatment. They left half of each irradiated area intact and extended into the neighboring skin, thus providing two test fields and two controls on each rat. Half the animals were killed seven days following the cutting; the other half as soon as the cuts had completely healed. The skin specimens were then prepared for microscopic examination.

In the second group, one field covering half of the length of the cut was exposed. The average area amounted to  $1 \times 3$  square centimeters. The cuts were made immediately, 24, and 48 hours, respectively, preceding the exposure. A longer interval was not feasible because healing of the wound had progressed by the end of the third day so far as to render impossible the macroscopic evaluation of the influence of roentgen rays on the healing process. Half of the rats were killed seven days following the exposure; the remaining half on complete healing of the cuts. The skin specimens were then prepared for microscopic examination.

Two types of roentgen rays were chosen in order to study, as a secondary question, the influence of the wave length on the biological reaction: (1) 100 K.V., 2.0 mm.

Al, 20 cm. F.S.D., lambda effective 0.34 Å. (transmitted through 2.0 mm. Al), 0.7 r per second; (2) 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 45 cm. F.S.D., lambda

## EXPERIMENTS

The macroscopic and microscopic findings will be recorded here, accompanied by a



Fig. 4. Rat D 3; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval. Fig. 4-A. Wounds on the fourteenth day following the incision. Fig. 4-B. Photomicrogram of the irradiated part of the cut.



Fig. 5. Rat F 1; 100 K.V., 2.0 mm. Al, 1,000 r. Ten-day E-C interval. Fig. 5-A. Wounds seven days following the incision. Fig. 5-B. Photomicrogram of the irradiated part of the cut.

effective 0.18 Å. (transmitted through 1.0 mm. Cu), 0.2 r per second. The apparatus used was a valve tube rectifier with condenser.

number of selected illustrations, since space does not permit the reproduction of the entire material in each group, *i.e.*, both for the same quality of radiation and for the same

intervals between the cutting and the exposure. From two to four rats were used in each group in order to allow for individ-

Scar 0.3 mm. wide. New connective tissue, with a few round cells. Beginning hyalinization.



Fig. 6. Rats A 1 and B 1; 100 K.V., 2.0 mm. Al, 1,000 r. Fourteen-day E-C interval. Wounds seven days following the incision. Fig. 6-A. Rat A 1. Fig. 6-B. Rat B 1.

ual variations. The following report is based on a total of eighty animals.

#### I. PRE-OPERATIVE IRRADIATION

(a) 100 K.V., 2.0 mm. Al, 1,000 r

*One-day E-C<sup>4</sup> Interval.*—Macroscopically there was no essential difference between the two halves of either cut on the seventh day following the cutting (Fig. 1-A). *Microscopic examination:* Depressed wound not epithelialized. Crust remains. Connective tissue growth poor in progress (Fig. 1-B). The wounds were healed on the eighteenth day, presenting a smooth scar throughout the full length of the cut. *Microscopic examination:*<sup>5</sup> Epithelialized, with keratin.

<sup>4</sup>This convenient abbreviation is used throughout the paper for "exposure-cutting."

<sup>5</sup>Unless otherwise stated, the microscopic reports refer to sections through the irradiated part of the cuts.

*Three-day E-C Interval.*—No difference could be noticed on the seventh day between irradiated and non-irradiated parts (Fig. 2-A). *Microscopic examination:* Incision gaping; not epithelialized. Considerable crust, in which many polymorphonuclears are found. No acute reaction in tissue. New connective tissue forming (Fig. 2-B). The wounds were healed on the eighteenth day, without perceptible influence of the exposure. *Microscopic examination:* Scar epithelialized, with keratin. New connective tissue, with beginning hyalinization. Width 0.3 millimeter.

*Seven-day E-C Interval.*—In one rat, the cuts showed a slight advance of the healing process in the irradiated part on the seventh day, while in other animals belonging to the same group we could not detect any influence of the exposure (Fig. 3-A). *Micro-*

Al, 20 cm. F.S.D., lambda effective 0.34 Å.  
(transmitted through 2.0 mm. Al), 0.7 r  
per second; (2) 140 K.V., 0.25 mm.  
Cu + 1.0 mm. Al, 45 cm. F.S.D., lambda

## EXPERIMENTS

The macroscopic and microscopic findings  
will be recorded here, accompanied by a



Fig. 4. Rat D 3; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval.  
Fig. 4-A. Wounds on the fourteenth day following the incision. Fig. 4-B. Photomicrogram of the irradiated part of the cut.



Fig. 5. Rat F 1; 100 K.V., 2.0 mm. Al, 1,000 r. Ten-day E-C interval.  
Fig. 5-A. Wounds seven days following the incision. Fig. 5-B. Photomicrogram of the irradiated part of the cut.

effective 0.18 Å. (transmitted through 1.0  
mm. Cu), 0.2 r per second. The apparatus  
used was a valve tube rectifier with con-  
denser.

number of selected illustrations, since space  
does not permit the reproduction of the en-  
tire material in each group, *i.e.*, both for the  
same quality of radiation and for the same

irradiated and unirradiated parts of the cuts. *Microscopic examination:* Cut epithelialized; slight crust. New connective

the fourteenth day, the cuts had healed. *Microscopic examination:* Scar not through muscle. Epithelialized, with keratin. Con-

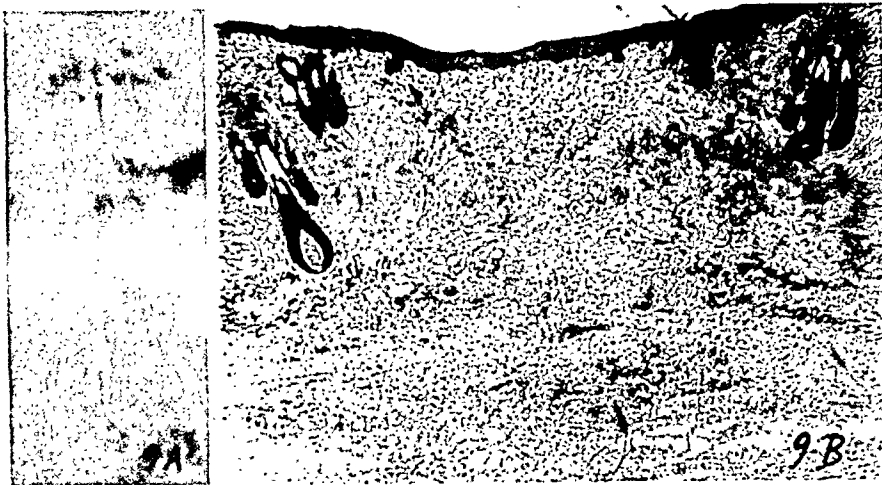


Fig. 9. Rat H 3; 100 K.V., 2.0 mm. Al, 1,000 r. Thirty-day E-C interval. Fig. 9-A. Wounds on the nineteenth day following the incision. Fig. 9-B. Photomicrogram of irradiated part of the cut.

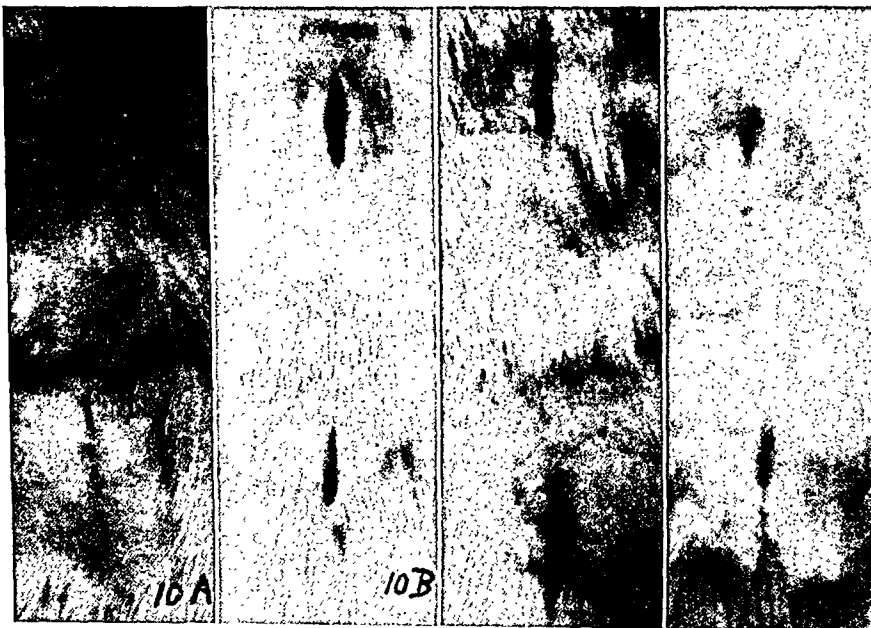


Fig. 10. Rats K 2, J 2, E 2, and F 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. One-, 3-, 7-, and 10-day E-C intervals. Wounds seven days following the incision. Fig. 10-A. Rat K 2, 1-day E-C interval. Fig. 10-B. Rat J 2, 3-day E-C interval. Fig. 10-C. Rat E 2, 7-day E-C interval. Fig. 10-D. Rat F 2, 10-day E-C interval.

tissue with round cells. No acute reaction. Average width, 0.4 mm. (Fig. 5-B). On

nective tissue is almost completely hyalinized.

*Fourteen-day E-C Interval.*—The cuts were covered by crusts on the seventh day. These were loose in the irradiated parts in some rats (Fig. 6-A), but showed no difference in others (Fig. 6-B). *Microscopic*

than in the previously observed animals. No difference could be detected between treated and untreated parts (Fig. 8-A). *Microscopic examination:* Cut completely epithelialized—crust removed. Scar consists



Fig. 11. Rat A 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Fourteen-day E-C interval. Fig. 11-A. Wounds seven days following the incision. Fig. 11-B. Photomicrogram of irradiated part of the cut.

*examination:* Incisions healed and keratinized. Epithelium much thicker over wound. Between the twelfth and fourteenth day, the cuts healed uniformly. *Microscopic examination:* Completely healed and keratinized. Scar very narrow. Does not extend through muscle. Occasional polymorphonuclear.

*Twenty-one-day E-C Interval.*—On the seventh day, the healing was well under way, without noticeable difference between the treated and untreated parts of the cuts (Fig. 7-A). *Microscopic examination:* Considerable crust, with partial epithelialization. Poor connective tissue reaction, very edematous (Fig. 7-B). On the fourteenth day, the cuts had healed. *Microscopic examination:* Epithelialized, with keratin. Narrow scar. Partly hyalinized.

*Thirty-day E-C Interval.*—On the seventh day, the cuts were covered by crusts; there was more gaping of the wound

of new vascular connective tissue, with some hyalinization in the deeper layers. No acute inflammatory reaction present (Fig. 8-B). On the nineteenth day, the wounds were well healed without macroscopic changes in the irradiated parts of the cuts (Fig. 9-A). *Microscopic examination:* Fully epithelialized, with keratin. Upper part of connective tissue is partly hyalinized. Considerable round-cell reaction in the deeper layer. A few foreign body giant cells around hairs (Fig. 9-B).

(b) 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r

In this group, the results did not differ in any characteristic manner from those observed in the rats exposed to the radiation of longer wave length. We confine the report, therefore, to the presentation of a few selected photographs and photomicrograms

demonstrating this fact. They were all taken seven days following the cutting.

*One-day E-C Interval.*—*Microscopic examination:* Epithelialized, with keratin. Width 0.3 mm. average. New connective tissue, with a few round cells (Fig. 10-A).

*Three-day E-C Interval.*—*Microscopic examination:* Not epithelialized; crust remains. Considerable fibrin in new connective tissue; 1.0 mm. wide (Fig. 10-B).

*Seven-day E-C Interval.*—*Microscopic examination:* Cut partially epithelialized, with crust. Considerable fibrin and serum remains in deeper layers. No acute reaction (Fig. 10-C).

*Ten-day E-C Interval.*—*Microscopic examination:* Cut epithelialized, with keratin. Scar very narrow and almost completely hyalinized (Fig. 10-D).

*Fourteen-day E-C Interval.*—*Microscopic examination:* Scar epithelialized, with keratin, very narrow (Fig. 11).

*Twenty-one-day E-C Interval.*—*Microscopic examination:* Almost epithelialized. Considerable crust remains. No acute reaction. New connective tissue, considerable edema, and many round cells (Fig. 12-A).

*Thirty-day E-C Interval.*—*Microscopic examination:* Epithelialized. Crust remains. Some acute reaction in upper layers. Considerable fibrin in deeper part (Fig. 12-B).

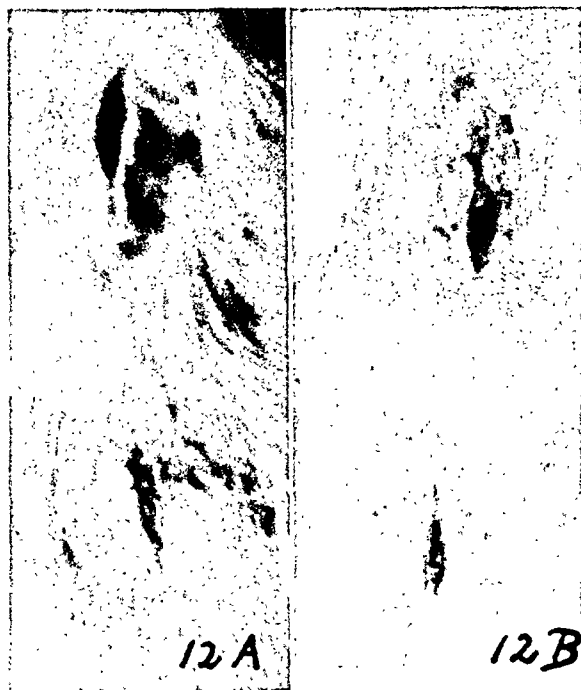


Fig. 12. Rats M 2, H 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Twenty-one- and thirty-day E-C intervals, respectively. Wounds seven days following the incision. Fig. 12-A. Rat M 2, twenty-one-day E-C interval. Fig. 12-B. Rat H 2, thirty-day E-C interval.

## II. POST-OPERATIVE IRRADIATION

(a) 100 K.V., 2.0 mm. Al, 1,000 r

*Exposure immediately after cutting.*—Seven days after the cutting, there was a slight retardation of the healing of the irradiated part in one rat, while the others



Fig. 13. Rat X 5, 100 K.V., 2.0 mm. Al, 1,000 r. Exposure immediately after cutting. Fig. 13-A. Wound seven days following the incision. Fig. 13-B. Photomicrogram of irradiated part. Fig. 13-C. Photomicrogram of untreated part.



in our animals did not produce skin reactions of the second or third degree. It was chosen because we knew from tests performed previously that, beginning at about 1,300 r, definite ulceration occurs in the skin of rats. One should logically expect an interference with the healing process of wounds in such an injured skin area. The cuts did not sever the muscle nor were the wounds sutured. With these facts in mind our material will be analyzed.

In the first group, in which the incisions were made in irradiated areas at intervals of from one to thirty days following exposure, it appeared both from the macroscopic and microscopic examinations that there was no definite evidence of retarded healing. The changes due to irradiation, as, for instance, thickening of the capillary walls, mitotic figures in the malpighian layer, and fibroblasts in the corium, have not been mentioned in each case since they repeated themselves throughout the sections. The dose used for both wave lengths corresponded to a threshold erythema for rat's skin, determined and controlled on more than one hundred animals. No effect of the wave length could be detected in any of the tests. If it is permissible to draw any comparisons with our clinical problems, we may assume that moderate roentgen-ray exposure from one to thirty days preceding the operation will not inter-

fere with the healing process in the skin following operation.

In the second group, representing post-operative irradiation, a definite retardation of the healing in the irradiated part of the incision was noticeable. The macroscopic as well as the microscopic studies brought out the fact that exposure twenty-four hours following the incision seemed to have the most pronounced inhibitive effect. After the incisions had completely healed, there appeared to be no difference between the exposed and unexposed parts of the scars. The total healing time varied from 15 to 22 days; in untreated rats, healing usually occurred within from 12 to 15 days. However, we do not wish to place too much value on this time interval. Towards the end of the healing period, it is quite difficult to reach a decision as to the exact date of the healing. Individual observers might easily disagree, since, for instance, a small piece of crust may remain attached for several days in one rat, while in another animal it may sooner become loose, either spontaneously or accidentally. This was most strikingly demonstrated in the first group, in which two cuts on the same rat had been made. Quite often one of these cuts presented a perfect scar from three to four days before the other cut had reached the same stage. Our conclusions rest, there-

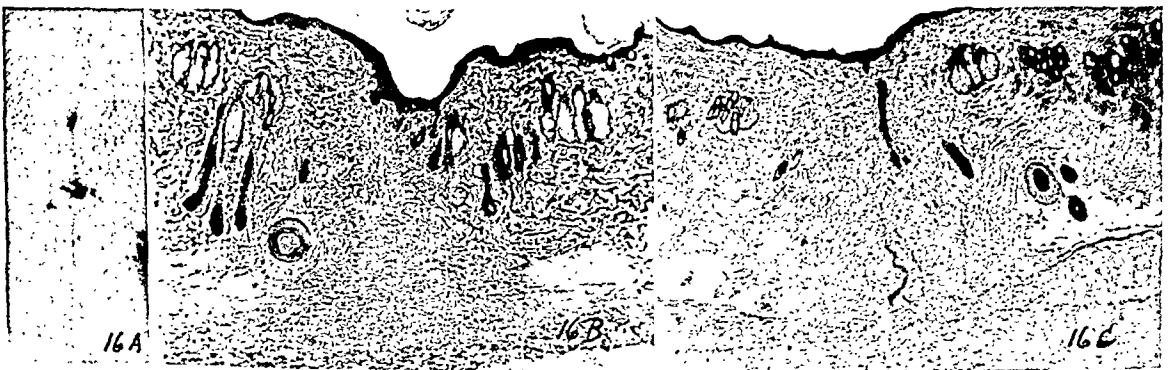


Fig. 16. Rat X 12, 100 K.V., 2.0 mm. Al, 1,000 r. Twenty-four-hour C-E interval. Fig. 16-A. Wound on twentieth day following incision. Fig. 16-B. Photomicrogram of irradiated part. Fig. 16-C. Photomicrogram of untreated part.

fore, mostly on the comparisons made on the seventh day. They lead us to believe that if retardation of the healing of the incision is judged to be undesirable, post-op-

ordinary knife. The same observation was reported by Schürch and Tschudi (7), who used, however, radium alone, while Hintze employed both X-rays and radium. The

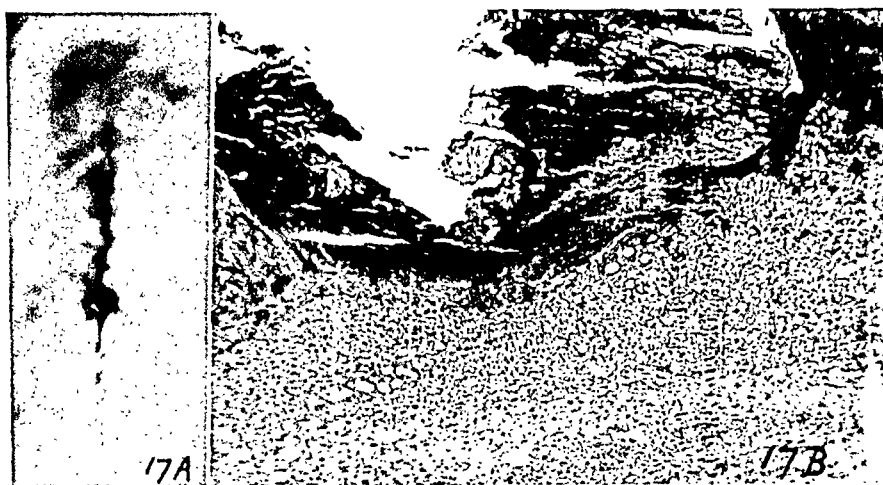


Fig. 17. Rat X 9, 100 K.V., 2.0 mm. Al, 1,000 r. Forty-eight-hour C-E interval. Fig. 17-A. Wound seven days following incision. Fig. 17-B. Photomicrogram of irradiated part.

erative exposure of surgical wounds should be carried out after the scar has been formed. This applies, of course, only to doses of roentgen rays as used in our experiments. However, should the immediate irradiation of the wound be deemed essential, the results of our experiments seem to indicate that a satisfactory scar formation can be expected, provided, again, that no excessive doses of radiant energy are administered. This deduction is borne out by clinical observations. Halberstaedter and Simons (5) found that wounds irradiated after operation showed delayed healing. The final scars were, however, more satisfactory than in the untreated cases. If one-half of an incision following the removal of a malignant tumor had been irradiated, it was noted in one patient that a recurrence appeared in the unexposed half only. According to Hintze (6), the delay is less pronounced if the tissue defect has been made by the electric cautery as compared with the

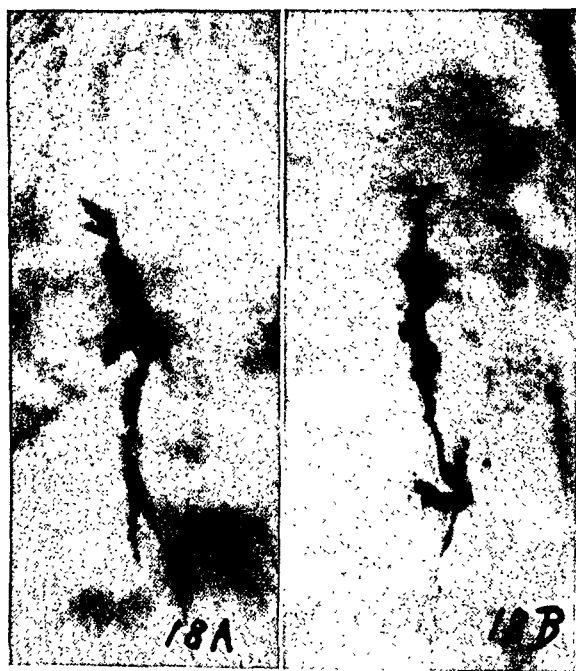


Fig. 18. Rats X 6 and X 10, 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Fig. 18-A. Rat X 6, exposure immediately after cutting. Wound seven days after the incision. Fig. 18-B. Rat X 10, forty-eight-hour C-E interval. Wound seven days after incision.

incision, so that he has almost given up pre- and post-operative irradiation in these cases. Other observers, for example, Dr. Ullmann, with a dose of 800, and another discussant, with 1,000 r applied over the breast, did not

see any retardation at all. I think the best solution of this problem will be to use the results of experimental work with discretion, and proceed then along lines of clinical investigation.

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**Principles of Prognosis in Cancer.** William C. MacCarty. *Jour. Am. Med. Assn.*, Jan. 3, 1931, XCVI, 30.

It is a mistake, with present knowledge, to use any one criterion as the basis of clinical prognosis in cancer. It is perfectly legitimate and proper to attempt grading. Clinical and pathologic experience show at least fifteen factors governing prognosis in cancer. They are as follows:

(1) Length of life is inversely proportional to the amount of glandular involvement and distant metastasis.

(2) The greater the fixation of a cancer to surrounding structures the greater the difficulty of surgical removal, the greater the immediate operative risk, and the less the chance for complete recovery.

(3) Malignant or benign tumors so located as to produce early pain, hemorrhage, mechanical obstruction, or an easily recognizable mass are more favorable.

(4 and 5) The lower the cardiac and renal efficiency, the poorer the prognosis, and especially the greater the immediate therapeutic risk.

(6) Anemia is associated apparently with two conditions: reduction of diet; hemorrhage, either single or constant or repeated oozing from the growth. Perhaps a third condition exists, namely, an anemia due to a theoretical toxic condition from the cancer itself or associated with its disintegration. The greater the anemia, the greater the immediate therapeutic risk and the shorter the length of life. That of a single or a recent repeated hemorrhage from the growth may not necessarily

alter the ultimate prognosis after the growth is removed.

(7) It has been established that there is a definite relation between the size and the presence of glandular involvement which, in turn, has prognostic value. The larger the primary growth, the greater the possibility of glandular involvement and hence the worse the prognosis.

(8) Generalizations regarding age alone, when applied to clinical practice, might sometimes be very misleading. It is perhaps correct to say, the younger the patient the worse the prognosis, keeping always in mind that all other factors have an influence regardless of age.

(9) Direction of growth, whether the bulk of the cancerous mass is toward the lumen or surface of the organ or whether it is infiltrating the wall and growing toward adjacent organs or vital cavities is a factor. The latter has the worse prognosis.

(10) As a single prognostic factor, loss of weight is probably of little significance, but taken in association with some or all of the other factors it adds gravity to any prognosis.

(11, 12, 13, and 14) There can be no doubt but that there is some relation between the degree of differentiation of tumor cells and their rate of growth; but size, location, infiltration, glandular involvement and fixation, lymphocytic infiltration, fibrosis, and hyalinization must all be taken into consideration.

(15) In general, the duration of the disease is mainly of value when taken in conjunction with other factors.

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# THE TECHNIC OF RADIOGRAPHY BY GAMMA RAYS\*

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**G**AMMA rays can be used in place of X-rays as a means of non-destructive testing of castings and welds for internal defects. It was shown by Mehl, Doan, and Barrett<sup>1</sup> that radiographs can be taken through ordinary sections of steel in a few hours, using as sources of  $\gamma$ -rays amounts of radium readily available at hospitals in the larger cities. The greater penetrating power of  $\gamma$ -rays compared with X-rays was pointed out, and examples reproduced of radiographs taken through thicknesses well beyond the range of usefulness of X-rays at present available.

The apparatus necessary for  $\gamma$ -ray radiography is very simple. A small container of radio-active material is supported rigidly in front of the specimen to be inspected, and X-ray films in suitable holders fastened to the back of the specimens.

Figure 1 shows the experimental arrangement used for taking four simultaneous radiographs of specimens built up of plates. A small glass funnel was used to hold the bulb of radium emanation in the center of the group. In Figure 2 a similar funnel is hung on strings in front of an arm of a forge press, and a film is placed behind it, without removal of the piece. Figure 3 shows the method that was used to explore a large cylindrical casting. Here the source of  $\gamma$ -rays was mounted on a stand within the casting, and films were fastened opposite the source, on the outside. It would have been possible to take radiographs simultaneously on a belt of films extending completely around this casting had it been desired. One of the operators is shown holding a lead-



Fig. 1. Arrangement used to radiograph experimental specimens. (Cf. Figs. 4 and 5.)

lined box containing a bulb of radium emanation eight inches in diameter.

The characteristics of the  $\gamma$ -ray method make it especially applicable to radiographic work through thicknesses above 2 or 3 inches of iron such as are found, for instance, with castings for high pressure steam power plants. When portability is necessary the method is again very appropriate, since no high voltage electrical apparatus is required. A lead-lined room is unnecessary, as the operator's simplest protection from the rays is merely to remain at a distance from the radium during the exposure, and to handle the radium with forceps.

It was the purpose of the previous paper to demonstrate the possibility of  $\gamma$ -ray radiography by exhibiting actual radiographs through a large range of thicknesses of steel, and by theoretical arguments. Such interest has been shown in this possibility, especially among the makers and users of large castings, that a definite technic for taking suitable radiographs is already in de-

\*Published with the permission of the Navy Department. Reprinted by permission from *Metals and Alloys*, December, 1930, I, No. 18, p. 872.

<sup>1</sup>Radiography by the Use of Gamma Rays. Trans. Am. Soc. for Steel Treating, Reprint, Chicago, 1930.

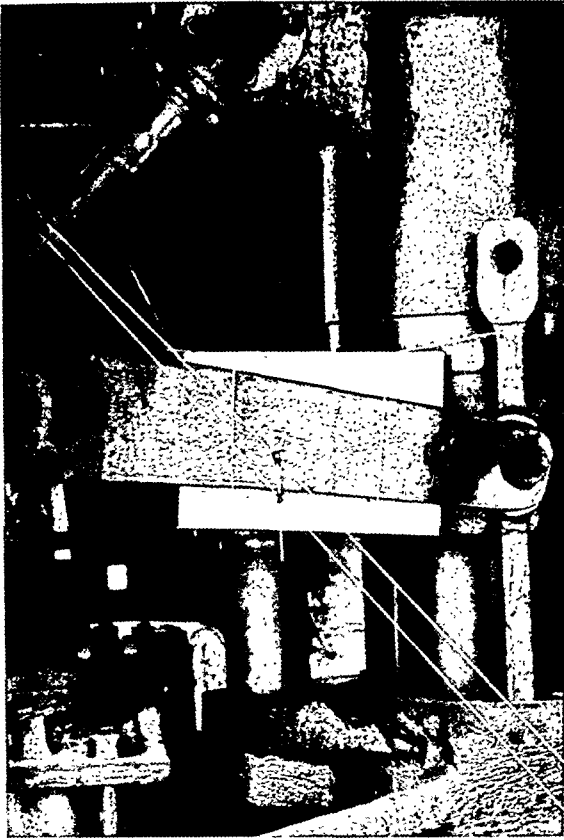


Fig. 2. Glass funnel, supported by strings, holds radium in front of an arm of a forge press for radiographic inspection *in situ*.

mand. From the cost standpoint, the importance of eliminating guesswork is obvious. Radium is not so cheap that its use can be a success in practice if any considerable percentage of radiographs taken with it are failures, or if advantage is not taken of means of increasing the efficiency of the process.

The present paper is an attempt to give definite recommendations and quantitative data for taking  $\gamma$ -ray radiographs. It seems advisable to discuss the physics involved in the technic in some detail; this is done under the headings, "The Source of Gamma Rays," "The Effect of Rays on Films," "Exposures Necessary," and "Scattering of Gamma Rays." In view of the simplicity of both apparatus and operations involved in  $\gamma$ -ray inspection, highly skilled labor seems unnecessary. A simple presentation of a

suitable technic is, therefore, in order, and while it may be lacking under the headings mentioned, the division "Operations in Practice" is intended to fill this need.

The difficulty of reproducing radiographs for publication is well known. A tremendous range of densities may be satisfactorily recorded on a film, but only a few appear on a print. To illustrate points in the discussion below, however, it is necessary to reproduce some actual radiographs regardless of the quality of the reproduction. This has been attempted in Figures 4 to 9, through photography of the original films placed on a viewing frame and illuminated by diffuse light from the rear. In some cases increased contrast has been obtained through the use of Process film and contrast printing; in other cases it was necessary to reduce contrast and suffer a corresponding loss of detail. No retouching has been done.

#### THE SOURCE OF GAMMA RAYS

The only radio-active material of practical importance seems to be radium; there are considerable amounts<sup>2</sup> of this distributed in several cities in the United States and used for medical purposes.

Radium decomposes at a constant rate into the gas radium emanation, which, in turn, produces a series of decomposing solids, some of which give off  $\gamma$ -rays.<sup>3</sup> The strength of these rays is proportional to the amount of radium emanation present. If the emanation is left in contact with the radium from which it forms, it builds up until equilibrium is reached, when its rate of formation equals its rate of decay, and its strength is then proportional to the amount of the radium. The amount of emanation in equilibrium with one gram of radium, as

<sup>2</sup>Figures do not seem to be available as to the amount of radium in the country. No radium has been produced in this country since 1925, but the U. S. Department of Commerce has estimated that 45 or 50 grams were imported during the years 1924-1929, and we understand it is being imported at an increasing rate.

<sup>3</sup>Practically all the gamma rays effective in radiographic work arise from the disintegration of Radium C.

measured by the intensity of the  $\gamma$ -rays emitted, is called a curie.

Radium emanation may be pumped from the parent radium, and sealed in small glass bulbs. In this form its strength decreases so that the intensity  $I$  of X-rays at any moment is  $I = I_0 e^{-\lambda t}$ , where  $t$  is the time interval that has elapsed since the intensity was  $I_0$ , and  $\lambda$  is a constant, equal to 0.007551, when  $t$  is measured in hours.

Table I gives values hourly for  $\frac{I}{I_0}$ .

Either radium or radium emanation may be used for radiography, but the necessary exposure times are different. When radium is used one has a source of a constant intensity, and the exposure obtained is proportional to the product of intensity and time,  $I_0 t$ . With emanation as a source the exposure is proportional to the integral of intensity with respect to time, *i.e.*,

$$\int_0^t I dt = I_0 \int_0^t e^{-\lambda t} dt = \frac{I_0}{\lambda} (1 - e^{-\lambda t}).$$

With the use of this formula Table II has been computed, giving the number of hours' exposure necessary with emanation to produce a result equal to a given number of hours' exposure with radium, when the strength of the emanation in millicuries at the beginning of the exposure is equal to the number of milligrams of radium. For example, if one desired exposure of 1,200 milligram-hours, it could be had with 100 milligrams of radium in 12 hours, 200 milligrams in 6 hours, etc.; but reference to Table II shows that if one started with 100 millicuries of emanation it would require 12.6 hours, or, starting with 200 millicuries, 6.1 hours would be necessary.

A less accurate method of calculating exposures is to assume that the decay is linear with time and that the mean strength of the emanation during an exposure is simply the average of the initial and final strengths. The errors in such calculations are negligible



Fig. 3. Radiographing a large cylindrical casting. Radium is held on a stand inside and films are fastened outside. (Cf. Fig. 9.)

in practice unless exposures are many hours long.

TABLE I.—DECAY OF RADIUM EMANATION\*  
(for  $\lambda = 0.007551$  hrs.; half life = 3.825 days)

Time $t$	Intensity $e^{-\lambda t}$	Time $t$	Intensity $e^{-\lambda t}$	Time $t$	Intensity $e^{-\lambda t}$	Time $t$	Intensity $e^{-\lambda t}$
0	1.0000						
1	0.9925	13	0.9064	25	0.8278	37	0.7560
2	0.9850	14	0.8996	26	0.8216	38	0.7504
3	0.9786	15	0.8929	27	0.8155	39	0.7448
4	0.9703	16	0.8861	28	0.8093	40	0.7391
5	0.9629	17	0.8795	29	0.8032	41	0.7336
6	0.9557	18	0.8729	30	0.7973	42	0.7282
7	0.9485	19	0.8662	31	0.7911	43	0.7225
8	0.9413	20	0.8597	32	0.7852	44	0.7171
9	0.9343	21	0.8533	33	0.7793	45	0.7117
10	0.9272	22	0.8468	34	0.7734	46	0.7064
11	0.9203	23	0.8405	35	0.7676	47	0.7010
12	0.9134	24	0.8343	36	0.7620	48	0.6960

\*Meyer-Schweidler, "Radioaktivität," Teubener, Berlin (1927), page 419.

#### EFFECT OF RAYS ON FILMS

In both X-ray and  $\gamma$ -ray work where but a minute fraction of the radiation passing through a film is absorbed by the emulsion, any method of increasing the photographic effect of the rays is of great practical importance. Eastman Superspeed Duplified X-ray films, with their large grain size and double emulsion are very fast. Overdevelopment further increases their speed. Satisfactory development technic consists of

developing in the standard Eastman X-ray Developer to which 20 milligrams of potassium iodide per liter have been added, for twice the length of time recommended for ordinary X-ray work at the various tem-

Secondary electrons ejected by the  $\gamma$ -rays are more completely absorbed in the emulsion than the  $\gamma$ -rays themselves, so that a copious emitter of secondary electrons in contact with the emulsion can considerably



Fig. 4. Radiograph of slotted steel plate arranged as shown in Figure 1. Total thickness, 4 inches; distance, source to film, 18 inches; exposure, 3,050 milligram-hours, using three lead intensifying screens with two films. Dimensions of slots as follows, from left to right:

Width in mm.	13	6	1	1	1	1	2	2	2	2	3
Depth in mm.	13	13	2	3	6	12	2	3.5	6.5	12	2

peratures.<sup>4</sup> For example, at 65° F. development may be prolonged to ten minutes, the potassium iodide preventing excessive fog. This technic was used throughout the work reported in this paper.

<sup>4</sup>A chart of standard developing times is given in "X-rays in Industry," Eastman Kodak Co., 1929.

increase the efficiency of the film. Lead foil<sup>5</sup> placed on both sides of the film was found to shorten the exposure times for  $\gamma$ -rays as it is commonly known to do for X-rays.

<sup>5</sup>The foil used was General Electric X-ray Corporation's "X-ray Foil," 0.006-inch thick.

TABLE II.—COMPARISON OF EXPOSURE TIMES  
IN HOURS FOR RADIUM AND FOR RADIUM  
EMANATION OF EQUAL INITIAL  
STRENGTH

Radium	Emanation	Radium	Emanation	Radium	Emanation	Radium	Emanation
1	1.0	11	11.5	21	22.8	31	35.4
2	2.0	12	12.6	22	24.0	32	36.6
3	3.0	13	13.7	23	25.3	33	37.9
4	4.0	14	14.8	24	26.5	34	39.3
5	5.1	15	15.9	25	27.7	35	40.6
6	6.1	16	17.0	26	29.0	36	42.0
7	7.1	17	18.2	27	30.2	37	43.4
8	8.2	18	19.3	28	31.5	38	44.8
9	9.3	19	20.5	29	32.8	39	46.2
10	10.4	20	21.6	30	34.0	40	47.6

Definite measurements are available on the intensity of this secondary electron emission under various conditions. Eve<sup>6</sup> measured with an electroscope the intensity of the electron emission from sheets of different elements for  $\gamma$ -rays filtered through 2 cm. of lead, separating the emission from the two sides of the sheets. The ionization in his electroscope due to electrons coming out of the side of the sheet upon which the  $\gamma$ -rays were incident as plotted in Figure 10 as the "incidence" curve, while the curve marked "emergence" gives the ionization caused by emission from the side of emergence of the  $\gamma$ -rays.<sup>7</sup> The preponderance of emission in the emergence direction for light elements has its explanation in the quantum theories of radiation. As the atomic number of the screen is decreased, an increasing proportion of the secondary electrons is made up of electrons recoiling under the impact of the quanta of  $\gamma$ -rays, which they deflect, or "scatter." These recoiling electrons obey the laws of conservation of energy and momentum in the impact and thus always go in the forward direction, in fact, with  $\gamma$ -rays, nearly all proceed at an angle less than  $45^\circ$  from the direction of motion of the primary  $\gamma$ -ray. With the heavier elements, on the other hand, the recoil electrons become

few in number compared with photo-electrons. Photo-electrons result when the  $\gamma$ -ray quanta are absorbed instead of deflected, and have a distribution in space quite different from that of the recoil electrons, so that the total emission from heavy elements is approximately the same from the incidence and emergence sides. The emergence ionization as a function of thickness of the sheet is plotted in Figure 11 for aluminum and lead from measurements by Bragg.<sup>8</sup> The ionization increases with thickness until the electrons starting at the incidence side of the sheet are unable to reach the emergence side; further increase in thickness simply reduces the intensity of the  $\gamma$ -rays without adding to the number of electrons emitted.

On the basis of Figures 10 and 11 then, the best foils to put in contact with double-emulsion films for  $\gamma$ -ray work would be lead for the side farther from the radium, and lead or aluminum on the near side; the lead foil should be from 0.2 to 0.4 mm. thick for maximum effect, and the aluminum 2 mm. or more. An actual test with X-rays through 4 inches of steel with 2 mm. aluminum, 0.15 mm. lead, and 0.3 mm. lead on the radium side of films proved that lead is preferable to aluminum both for speed and definition; 0.15 mm. of lead appeared slightly more effective than 0.3 millimeter.

Materials which fluoresce under the action of  $\gamma$ -rays can be made into effective intensifying screens as has been done for X-ray radiography. Calcium tungstate screens are satisfactory in the  $\gamma$ -ray region, although their effectiveness in shortening exposure times for  $\gamma$ -rays is not as great as for high voltage X-rays. When used with X-rays their intensifying action increases with the hardness of the rays; that this increase does not continue into the  $\gamma$ -ray region of wave lengths is seen from the measurements of Figure 12. Scattered  $\gamma$ -rays reaching the

<sup>6</sup>A. S. Eve: Philosophical Magazine of London, Edinburgh, and Dublin, 1909, XVIII, 275.

<sup>7</sup>No importance should be attached to the actual values of the ionization plotted here, for an unknown but constant amount must be subtracted from these values to correct for ionization from causes other than those here discussed.

<sup>8</sup>W. H. Bragg and J. P. V. Madsen: Philosophical Magazine of London, Edinburgh, and Dublin, 1908, XVI, 918.



film from the rear, in radiographic work, are considerably longer in wave length than the original  $\gamma$ -rays and might fall within the range of greatest intensifying action for calcium tungstate screens. If this were the

with a hole 1 inch in diameter extending through it was used to collimate a beam of  $\gamma$ -rays from 250 millicuries of radium emanation placed at the bottom of the hole. The films under test were placed on the top

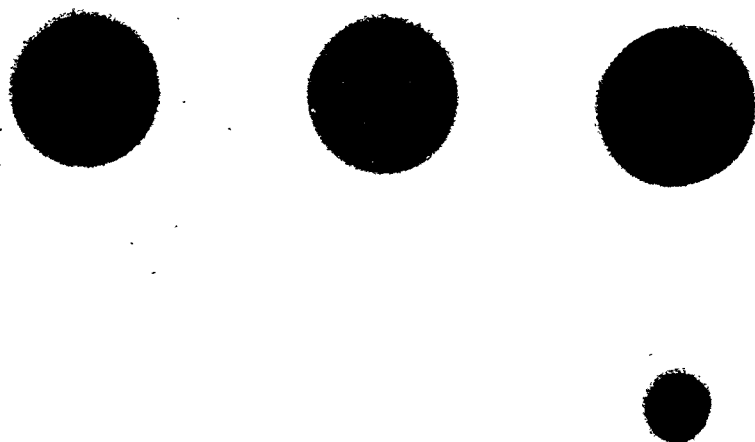


Fig. 5. Radiograph of drilled steel plate, shown in Figure 1, with total thickness of  $1\frac{1}{2}$  inches; distance, source to film, 18 inches; exposure, 175 milligram-hours, using three lead screens and two films. Dimensions of holes: (top row) 1 inch diameter;  $1\frac{1}{2}$  inches, 1 inch, and  $\frac{3}{4}$ -inch deep: (middle row)  $\frac{1}{2}$ -inch diameter;  $\frac{5}{8}$ -inch,  $\frac{1}{2}$ -inch, and  $\frac{3}{8}$ -inch deep: (bottom row)  $\frac{1}{2}$ -inch diameter;  $\frac{1}{8}$ -inch,  $\frac{1}{8}$ -inch, and  $\frac{1}{8}$ -inch deep.

case it would be doubly important to shield radiographic films from side and rear scattering when using such screens.

The characteristics of Eastman Super-speed Dupli-tized X-ray films under various conditions are shown in Figure 13. The method of obtaining the data was as follows: A lead cylinder 8 inches in diameter

of a block of iron 1 inch thick placed over the hole, and were 9 inches from the radium. Exposures of from 1 to 32 minutes were made and the films over-developed with the technic described above. Densities of the unexposed film and the exposed spots were calculated from measurements on a Kipp and Zonen microphotometer by taking

the logarithm to the base of the ratio of intensities of light passing through an undeveloped, fixed, washed, and dried film, to the intensity of the light passing through the film whose density was desired. That is, the density was taken as

$$\log_e \frac{\text{light incident on the emulsion}}{\text{light transmitted by the emulsion}}$$

The density due to the fog alone (amounting to about 1.15) was then subtracted from the densities of the exposed portions for each film and the difference plotted against the exposure time in Figure 13. The results show films surrounded by two Patterson screens to be the fastest of those tried, then, in order, one Patterson screen and one lead screen, two lead screens, and finally plain film without screens. Radiographic exposures made with two Patterson screens require about 0.6 the time required without screens, while with two lead screens this fraction is about three-quarters.

In all our radiographic tests we have used duplicate films. There is a considerable advantage in making a simultaneous exposure on two films; not only may the exposure be shortened, but, perhaps more important than that, the irregularities in the emulsions originating in manufacture and subsequent handling do not occur in the same spots on both films and are, therefore, averaged out. A great deal more confidence is felt in interpreting a faint marking as caused by a defect in a radiographed specimen if the same marking is seen on two films. The advisability of using more than two films appears questionable to the authors, however. The "confidence factor" does not increase appreciably, and the density due to the fog alone, with all the films combined, becomes too great—at least with the developing technic used in this work. Of course, the film costs also increase with the multiplicity of films used.

Two arrangements found convenient when using a pair of films are: lead—film—

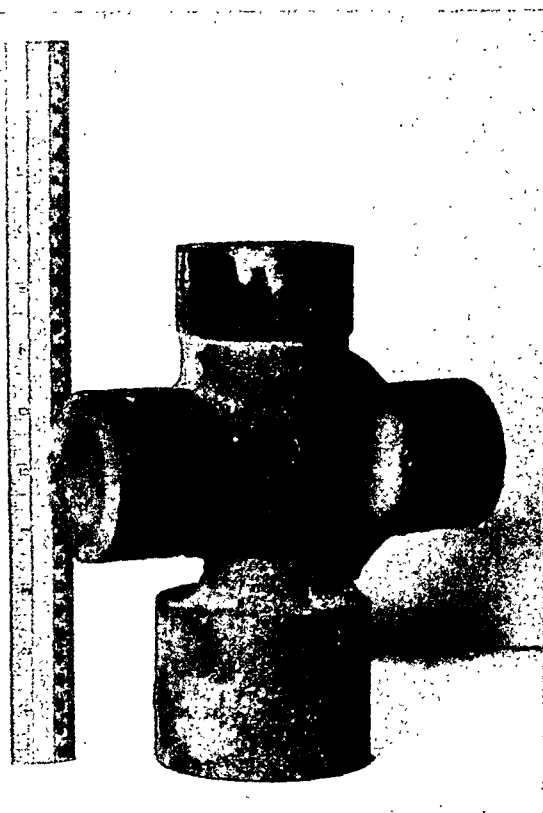


Fig. 6. Photograph of bronze valve casting of which radiograph is shown in Figure 7.

lead—film—lead, or when using fluorescent screens: screen—film—lead—film—screen. With these arrangements the films are separated only by the thickness of one lead sheet, and are contained in a single film holder, two conditions that are obviously desirable.

#### EXPOSURES NECESSARY

Upon penetrating a substance  $\gamma$ -rays decrease in intensity by absorption and scattering. The rate of decrease appears different when measured with different arrangements of apparatus. This has been shown to be the effect of varying amounts of the scattered rays reaching the measuring instrument along with the primary rays.<sup>9</sup>

<sup>9</sup>For summaries of this work see Rutherford: "Radioactive Substances and Their Radiations," Cambridge, 1913, pages 258-263; Meyer and Schweidler, "Radioaktivität," pages 149-156; Handbuch der Experimental Physik, XV, 70-74.

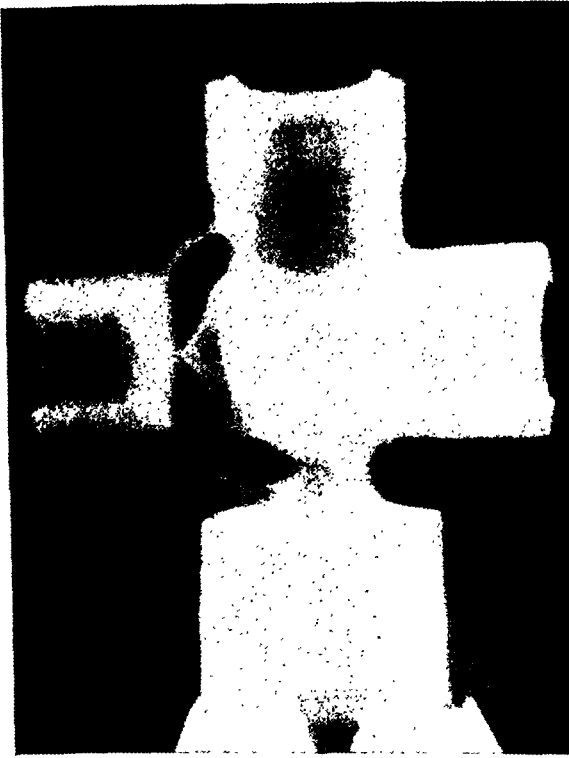


Fig. 7. Radiograph of bronze valve casting shown in Figure 6. Distance, source to film,  $27\frac{1}{2}$  inches; exposure, 1,600 milligram-hours; two lead screens; one film. Several flaws are visible in the original film.

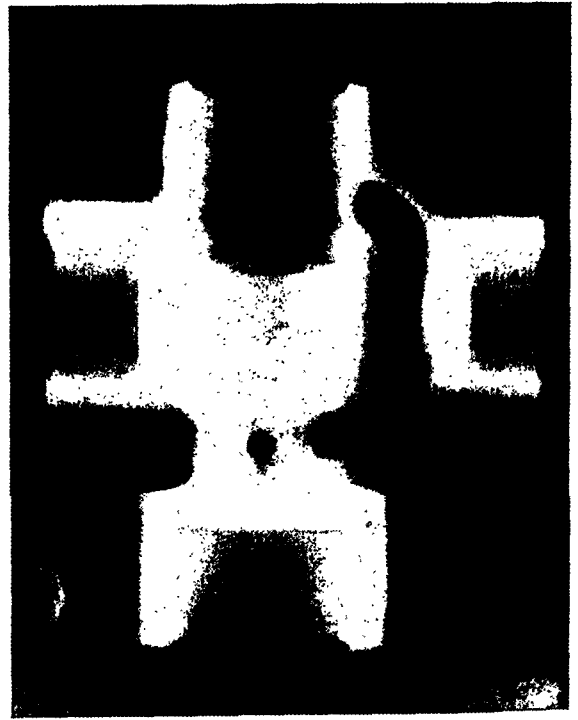


Fig. 8. Radiograph of a machined bronze valve casting. Distance, source to film,  $27\frac{1}{2}$  inches; exposure, 1,600 milligram-hours; two lead screens; one film.

The position of radium, specimen, and film in radiography is a particularly poor one for getting the true rate of decrease of the primary ray since the film receives a maximum amount of the scattered rays. Therefore, accurate measurements of true absorption, made with the absorbing screen near the radium and far from the measuring device to eliminate the effect of scattering, cannot properly be used to calculate the intensity striking the film in a radiographic exposure.

Absorption measurements under conditions approximating those of radiography were made by Soddy and Russell,<sup>10</sup> K. W. F. Kohbrausch<sup>11</sup> and others. It was found that the intensity of a ray of original inten-

sity  $I_0$  after passing through a thickness  $x$  of a metal of density  $\rho$  was

$$I = I_0 e^{-\mu x} = I_0 e^{-\left(\frac{\mu}{\rho}\right) \rho x}$$

where  $\mu$  is the linear absorption coefficient and  $\left(\frac{\mu}{\rho}\right)$  the mass absorption coefficient. Some values found for these coefficients are given in Table III. Soddy and Russell

TABLE III.—ABSORPTION COEFFICIENTS FOR  $\gamma$ -RAYS FROM RADIUM ACCORDING TO SODDY AND RUSSELL

Metal	$\mu$ (cm. <sup>-1</sup> )	$\mu/\rho$
Fe	0.304	0.0399
Cu	0.351	0.0398
Brass	0.325	0.0389
Al	0.111	0.0401
Pb	0.495	0.0434

found a constant value of  $\mu$  in lead from 2 to 22 cm. thick, and similarly found constant values over large ranges of thickness in other materials. Later observers were

<sup>10</sup>F. Soddy and A. S. Russell: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1909, XVIII, 620. Mr. and Mrs. Soddy, and A. S. Russell: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1910, XIX, 725.

<sup>11</sup>Summarized: *Handbuch der Experimental Physik*, XV, 71.

able to detect a hardening of the rays as they penetrated greater thicknesses, caused by the more rapid absorption of the softer components, and resulting in a progressive decrease in  $\mu$  with increasing thickness, an effect doubtless hidden from the earlier investigators by the presence of considerable

varies with the thickness according to the relation

$$t = t_0 e^{\mu x} = t_0 e^{\left(\frac{\mu}{\rho}\right) \rho x}$$

where  $t_0$  is the time required with  $x = 0$ . The derivation of this equation assumes (1)



Fig. 9. One of the radiographs of the large casting shown in Figure 3. A long crack, slightly obscured by streaks due to irregularities in the surface of the casting, is seen below and to the right of the lead identification figure "2." Exposure, 5,100 milligram-hours, with three lead screens, two films; distance, source to film, 31 inches.

scattering in their work. Taking the simple exponential equation above as representing absorption in radiography, the exposure time required to give a certain density on a photographic film behind  $x$  cm. of metal

that a constant source of intensity is used, (2) that the effect on a film is the product of intensity times time, a valid assumption, and (3) that the film is completely protected by lead shields from scattered rays reaching

it from the rear (excited by primary rays striking the walls, floor, etc.).

As there was some doubt as to just how well the above formula and values of Table III would serve to establish radiographic ex-

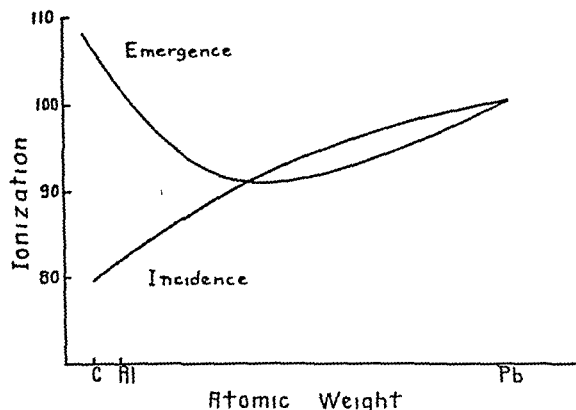


Fig. 10. Ionization produced by secondary electrons from screens of various atomic weights when radiated by gamma rays from radium (A. S. Eve).

posure times, it was decided to determine exposure times under actual conditions.

Steel plates 12 inches square and steel disks 16 inches in diameter were arranged about a holder of radium emanation as shown in Figure 1. Films were shielded from  $\gamma$ -rays scattered from walls and floor by lead sheet  $\frac{1}{8}$  inch thick shown tied to the back of the piles of plates. Various slots and holes were cut in the plates next to the emanation to test the thickness of defect that could be detected. A distance of 18 inches from source to film was used throughout the test. With a given thickness of plates and type of intensifying screen two exposures were made and the density measured at points on the films corresponding to the full thickness of metal. The exposure times actually used were transformed to the times that would be required for corresponding exposures with 100 milligrams of radium. Plotted on semi-logarithmic paper these times and densities, for a given thickness, gave two points on a curve of the type shown in Figure 13. These points located the time-density curve with suffi-

cient accuracy since only the position of the curve along the time axis, not its shape, is affected by the thickness of the absorbing plates. The time required to give any desired degree of blackening could then be

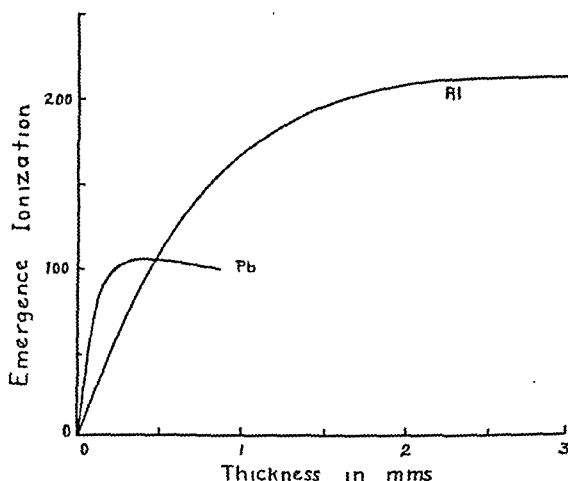


Fig. 11. Ionization on the emergent side of screens of various thicknesses, when radiated by gamma rays of radium (Bragg and Madsen).

read from the curve. Such exposures were used that the desired point lay either between the two used, or very close to one.

The proper amount of blackening for radiographs has been studied in detail by Neeff<sup>12</sup> but it is difficult to believe that the optimum density for viewing small changes in density of a film is independent of the intensity of the viewing light, as he appears to assume. For viewing two superimposed films, each of which shows rather more fog than usual because of the method of over-development used, the optimum density recommended by Neeff can hardly be given much weight. We have chosen a density, including fog, of 2.20 (in natural logarithms); with this blackening flaws 2 to 3 per cent of the specimen's thickness are seen with specimens from 2 to 6 inches thick.<sup>13</sup>

<sup>12</sup>Th. Neeff: *Ztschr. f. tech. Physik*, 1925, VI, 208-216; reviewed by Glocker: "Materialprüfung mit Röntgenstrahlen," Springer, Berlin, 1927, pages 65-69.

<sup>13</sup>In the absence of scattering, the ability to detect a hole is independent of the thickness of the specimen, since it leads to an increase in the intensity reaching the film by a factor of  $e^{\mu d}$  where  $d$  is the depth of the hole and  $\mu$  the absorption coefficient of the metal. In practice, this relation does not hold, for scattering is present and is a function of the thickness.

This density is suitable for viewing two superimposed films simultaneously and is also satisfactory for viewing a single film in close contact with white paper by reflected light.

blackening was that expected within the limit of accuracy of the experiment. This rule is convenient when making up a plaster to coat the surface of an irregular casting for the purpose of eliminating shadows of

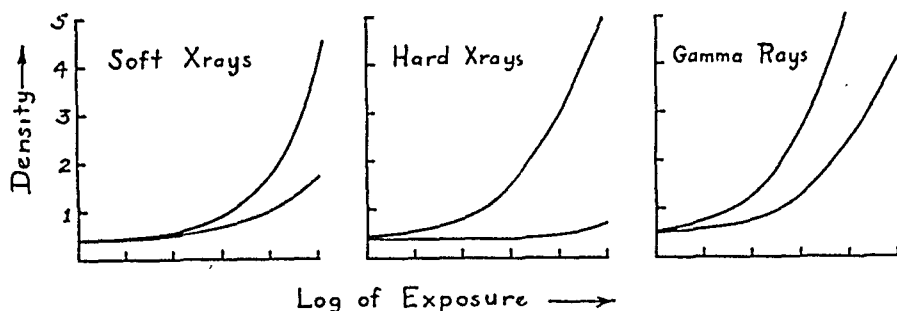


Fig. 12. Effect of Patterson screens on film density with radiation of different wave lengths. Upper curves, density with screen; lower curves, density without. Soft X-rays from molybdenum tube at 30,000 volts, A.C.; hard X-rays from tungsten tube at 140,000 volts, D.C., filtered through 4.5 mm. copper; gamma rays from radium emanation filtered through 1 inch of iron.

The results of the test are given in Figure 14. For thicknesses above two inches the slope of the curves has been made to correspond to a linear absorption coefficient of  $\mu = 0.304$ , in agreement with Soddy and Russell's value (Table III). Curves are given for two arrangements of screens and one density; data for other screens or other densities can be obtained from these by multiplying the exposure times by suitable factors (equivalent to a displacement of these curves along the axis of abscissas).

It will be seen from Table III that the mass absorption coefficient,  $(\frac{\mu}{\rho})$ , has nearly a constant value for different elements. From the exposure time equation above it is seen that the following convenient approximate rule can be formulated: the exposure necessary for  $x$  inches thickness of a metal of density  $\rho$  is the same as that necessary for  $\rho x / 7.8$  inches of steel, where 7.8 is the density of steel. This was tested with aluminum ( $\rho = 2.7$ ) by giving a 5-inch thickness the exposure necessary for  $2.7 \times 5 / 7.8 = 1.73$  inches of iron; the resulting

surface defects from the radiograph. Any plaster will do that has the same density as the casting.

The exposure necessary for a radium-to-film distance of  $d$  inches can be obtained from the exposure at 18 inches by multiplying the latter by  $(d/18)^2$ . The distance used in practice will depend upon the number and size of objects that are to be radiographed at one time and upon the definition—the sharpness of the image—that is desired. The smaller the source and the greater its distance from the defect, the greater the sharpness of the defect's shadow. Another important advantage obtained with a greater distance is a more uniform intensity over the area of the film. For the most economical use of radium, the objects to be tested should be placed about the radium to cover the greatest possible fraction of the total solid angle about it; they may be placed at such distances that the various thicknesses reach their completed exposures in the same number of hours. When the whole of the spherically radiated energy from the radium

The proportion of scattering at large angles increases with increasing wave length and is one of the causes for the need of careful shielding of the film when using X-rays. The Bucky diaphragm, a device of

a given point in a specimen being radiographed. Taking measurements of Compton's<sup>15</sup> we have estimated the relative intensity of scattered  $\gamma$ -rays reaching different points at the rear of a lead sheet 1 inch

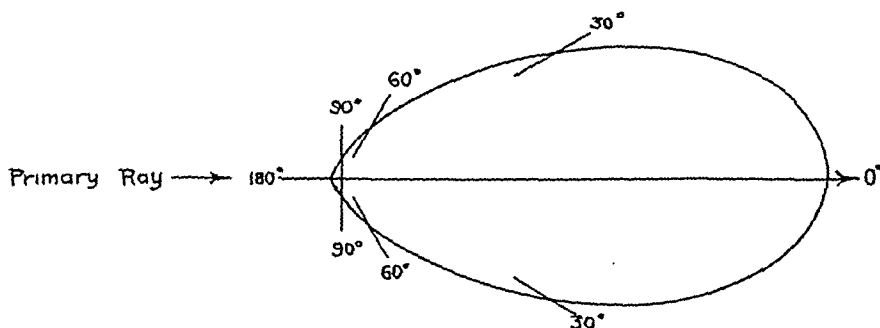


Fig. 15. Distribution in angle of intensity of gamma rays from radium scattered by iron (A. H. Compton).

multiple slits placed between the specimen and the film and very useful in radiography of the human body with the long wave lengths necessary for that purpose, could not be expected to add much to the quality of  $\gamma$ -ray radiographs. Its purpose is to prevent radiation scattered at an angle greater than a certain given angle from reaching the film. It is, therefore, an artificial method of producing a distribution of scattered rays of the favorable type shown in Figure 15 and would naturally be most effective when the original distribution differed most from this, *i.e.*, with soft X-rays.

The wave length of the scattered rays is another factor to be considered, for it is much greater than that of the primary rays. If the primary wave length be taken as 0.010 Å.u., then a ray scattered at 90° has a wave length of 0.034 Å.u. and at 180°, 0.058 Ångström unit. With this increase in wave length goes a decrease in the hardness of the ray. This is so pronounced that at large angles of scattering the rays are no harder than high voltage X-rays.

Knowledge of these factors enables a calculation to be made of the area of film which will be fogged by the scattering from

thick, assuming a small element of volume on the radium side of the sheet as the only source of scattering. Because of the distribution-in-angle of intensities, the softening upon scattering, the different thicknesses traversed by the scattered rays, and the weakening according to the square of the distance from the source of scattering, this element of volume can cause fogging over a circle only an inch or so in diameter, as shown in Figure 16. (The intensity of the primary ray is not indicated in the figure.) While this example represents a simplified case not found in practice, it is sufficient to show an important point, namely, that a specimen of great length and breadth can be radiographed with practically no more fogging from scattering arising in the specimen than one would experience with a small specimen of the same thickness.

For best results films should be shielded from scattered rays reaching them from the rear (originating in the walls and floor of the room), although the amount of this is not excessive. Figure 4 taken through 4 inches of steel had part of the film pro-

<sup>15</sup>A. H. Compton: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1921, XLI, 749.

tected from this rear scattering by an  $\frac{1}{8}$ -inch thickness of lead; another part was protected by a  $\frac{1}{4}$ -inch thickness. As is seen, the fog was reduced by the  $\frac{1}{8}$ -inch sheet, but no further reduction was effected by the additional  $\frac{1}{8}$ -inch.

#### OPERATIONS IN PRACTICE

An imaginary case will serve to illustrate the process of taking  $\gamma$ -ray radiographs with the technic recommended above and will indicate the simplicity of the method. Let us assume that radiographs are to be taken of two castings, one of steel of maximum thickness (in the direction it is desired to send the rays) of 4 inches, the other of bronze of maximum thickness 3 inches, and suppose that the source available for the work is radium emanation of strength 350 millicuries at the time the exposure is to start, enclosed, say, in a small needle-shaped container.

The initial cost of lead foil for intensifying screens is much less than that of calcium tungstate screens. The choice between these two types will depend on whether the saving in radium costs through the use of the more efficient calcium tungstate screens will pay for their greater initial cost. In this example we will assume lead foil is used, and that properly designed film holders are on hand. A desirable arrangement in each film holder is to alternate two films and three lead screens.

The source assumed, being needle-shaped, amounts to nearly a point source if viewed from the ends, so the most advantageous position for the two castings is in line with the axis of the needle. Their distance from the needle will now be considered. The greater the sharpness desired in the radiographs, the greater must be the distance from source to film and the smaller must be the dimensions of the source. Larger films require greater distances than small

films, in order to have uniform blackening over the surface of the film. Suppose comparison with previous results indicates the source-to-film distance should be at least 18 inches (a distance found satisfactory in the

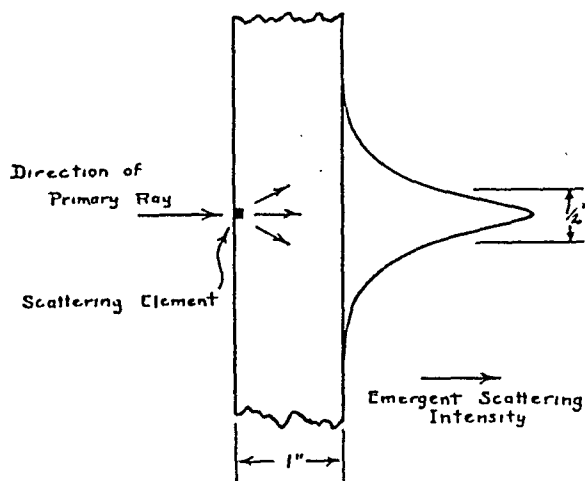


Fig. 16. Distribution of intensity over the back of a lead block, of gamma rays scattered by an element of volume in the front surface of the block.

work in this Laboratory). The exposure may then be calculated for the larger casting using this distance.

From the chart of Figure 14 the exposure for 4 inches of steel at 18 inches with lead screens and Eastman Dupli-tized X-ray film is seen to be 21 hours for 100 milligrams of radium, or  $21 \times \frac{100}{350} = 6.0$  hours for 350 milligrams. The equivalent exposure using radium emanation of 350 millicuries strength at the beginning of the exposure is obtained from Table II and is 6.1 hours.

The bronze casting may be placed at 18 inches and its exposure time calculated, or it may be placed at such a distance that it will require the same length of time as the steel casting. The latter scheme is often more convenient and will be assumed in this illustration. The thickness of 3 inches assumed for bronze is first to be reduced to its equivalent thickness of steel by multiplying by the density of the alloy and dividing by



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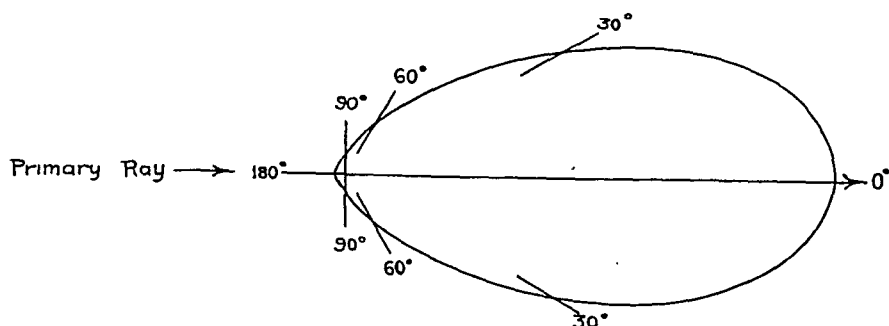


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The wave length of the scattered rays is another factor to be considered, for it is much greater than that of the primary rays. If the primary wave length be taken as  $0.010 \text{ \AA.u.}$ , then a ray scattered at  $90^\circ$  has a wave length of  $0.034 \text{ \AA.u.}$  and at  $180^\circ$ ,  $0.058 \text{ \AA.u.}$  With this increase in wave length goes a decrease in the hardness of the ray. This is so pronounced that at large angles of scattering the rays are no harder than high voltage X-rays.

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<sup>15</sup>A. H. Compton: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1921, XLI, 749.

# GASTROJEJUNOCOLIC FISTULÆ<sup>1</sup>

By H. W. WIESE, B.S., M.D., St. Louis, Missouri

OUR attention has recently been called to the condition of gastrojejunocolic fistula by the appearance of a case on the medical service of Barnes Hospital. This patient presented characteristic symptoms and X-ray findings, and was subjected to successful surgical treatment. Upon review of our hospital records another case was found which had been admitted with a clinical diagnosis of purpura. In the latter instance the patient died within twelve hours of admission to the hospital and the fistula was not suspected until the autopsy.

## SUMMARY OF CASES

Case 1. A. C., aged 31, a white male, married, was admitted to Barnes Hospital from the Outpatient Department in October, 1929. He complained of diarrhea, of pain in the abdomen, and also of pain in the muscles.

*Past history:* The patient had had frequent attacks of tonsillitis, and a peritonsillar abscess three years before admission. Fifteen years previous to the present examination he began having a burning pain in the epigastrium two hours after meals. This was relieved by food and soda. He was treated medically for several years, without relief. In 1923 he had a gastroenterostomy, after which his symptoms improved but he was not entirely free of discomfort. In 1925, the pain again becoming quite severe, the man received hospital treatment for thirty-four days on a rigid ulcer régime. He then followed a similar but ambulatory régime for two years, with considerable benefit, but upon resuming a normal diet, the severe symptoms returned. He then resorted to a diet of his own choos-



Fig. 1. Case 1. The opaque meal showing the filling of the distal transverse colon *via* the gastrocolic fistula.

ing and was quite comfortable until the onset of the condition from which he now sought relief.

The present illness began six months previous to admission, with a diarrhea which resulted in five or six stools each night, and two or three stools each day. The fecal matter was watery and contained some mucus. There was cramping in the lower abdomen below the site of his original ulcer pain. He consulted a physician and underwent a gastro-intestinal X-ray examination, but no abnormality was found. He was given a diet and an antacid. The diarrhea increased, with three or four stools at night and ten to twelve during the day. Fourteen weeks before admission he became too weak to work and was confined to bed. Two weeks later, he began to have a dull aching pain,

<sup>1</sup>From the Department of Medicine, Washington University, and Barnes Hospital, St. Louis, Mo.



Fig. 2. Case 1. The opaque enema showing the canalization of the gastrocolic fistula, and the filling of the stomach from the colon.

in the arms and legs, not localized to the joints. Two weeks after that, edema of the ankles and puffiness of the face appeared. Hemorrhoids developed. Seldom was there fever. He had lost twenty pounds in weight during the past six months. The appetite remained good throughout.

The physical examination revealed a pale, poorly nourished man, without fever. Eyes, ears, nose, throat, lungs, and heart were not notably other than normal. The blood pressure was 132 mm. systolic and 88 mm. diastolic. The abdomen showed an upper right paramedian scar of an operation for gastro-enterostomy, and a scar of an appendectomy at the McBurney site. There was a slight diffuse tenderness in the right upper quadrant.

The red cells were 3,370,000; the white cells 9,100, and the hemoglobin 70 per cent. The blood Wassermann and Kahn serum reactions were negative. The non-protein blood nitrogen was 26 mgm. per 100 cubic centimeters. A gastric analysis revealed much

mucus and débris in the contents of the fasting stomach, without free hydrochloric acid, and a combined acidity of 1 degree. A guaiac test for occult blood was faintly positive. At 20 minutes after the test meal the free acid was 10° and the combined acid 1°; at 40 minutes, free acid and the combined acid were 2° and 1°, respectively, and at 60 minutes 5° and 2°, respectively. The stool gave a moderately positive guaiac reaction for occult blood. The urine was negative. The roentgenologic examination showed the gastric clearance to be occurring *via* three openings: the pylorus seemed to have ready clearance; the gastro-enterostomy was functioning, and a gastrocolic stoma canalized readily. The duodenal cap was atypical in shape but without any irritability suggestive of an active ulceration. The second duodenum was markedly hypotonic. A barium enema readily canalized the gastrocolic fistula and the stomach filled promptly by this means.

At an operation Oct. 17, 1929, by Dr. Glover H. Copher, the scar of the original ulcer was found in the first portion of the duodenum. The loop of the jejunum distal to the gastro-enterostomy was inflamed and adherent to the colon. A gastrojejunocolic fistula was made out. The jejunum was separated from the colon, and the opening in the colon was sutured. The gastro-enterostomy was separated, the stomach closed, and a portion of the jejunum was excised and continuity restored. The post-operative course was uneventful and the patient was discharged from the hospital Nov. 15, 1929, and has since been observed in the Outpatient Department. During the first three months post-operative he gained thirty pounds in weight, and he has been entirely free of all symptoms.

Case 2. W. A. R., aged 61, a white male, single, was brought into Barnes Hospital Nov. 25, 1928, in a comatose condition. Because of this, it was impossible to secure a

detailed history. It was determined that he had had typhoid at the age of 20, pneumonia at 21, and that ten years previously he had been operated upon in New York City for a duodenal ulcer. During the past five

technique on the under-surface of the nose. The gums, and the hard and soft palates showed many purpuric spots. There was a definite purpura over the entire trunk. A few moist râles were found in the base of

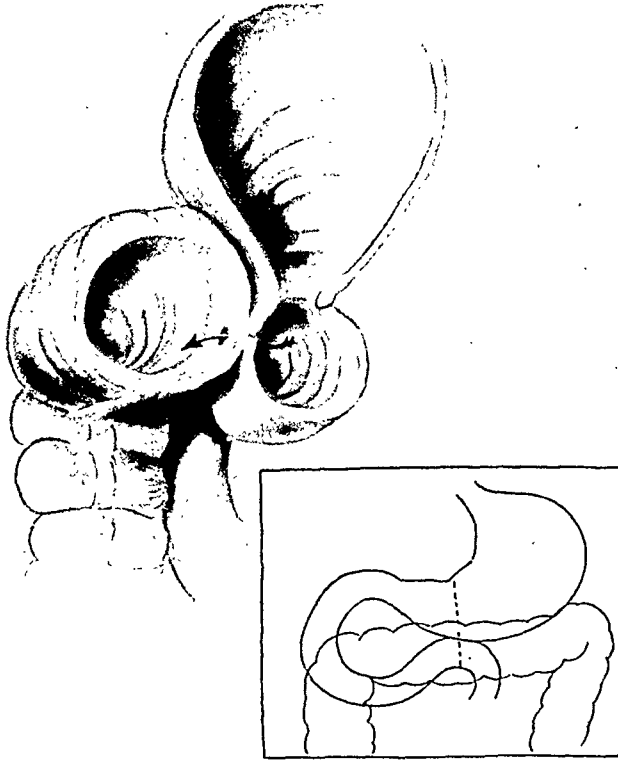


Fig. 3. Case 1. Sketch showing the fistula and the relations of the segments as found at operation.

years, he had had five or six bowel movements a day. The stools did not contain blood or mucus. During the five weeks prior to admission to the hospital he had received "serum treatment" in a clinic not affiliated with this institution.

A physical examination showed a stuporous patient having a temperature of  $36^{\circ}$  C. and a pulse of 140, which was weak and irregular. The pupils were small, and the right was, besides, slightly irregular and gave no reaction to light. There were pe-

both lungs. The blood pressure was 60 mm. systolic and 40 mm. diastolic. The abdomen showed a long upper right paramedian scar, but otherwise was not notable. Rectal examination revealed a slightly enlarged prostate. There was a distinct swelling in the midline of the perineum, with some tenderness and no redness.

The red blood count was 3,550,000, the white cells were 18,400, and the hemoglobin 60 per cent. The blood Wassermann and Kahn reactions were negative. The non-

protein blood nitrogen was 125 mgm. per 100 cubic centimeters. A blood smear showed only slight irregularity of the red cells. A fair number of platelets were visible. With catheterization, much blood drained out, reducing the mass in the perineum, and the catheter had evidently entered a blind cavity.

The patient's condition became rapidly worse and he died the morning after admission.

At autopsy the only findings referable to the subject of this paper was an anastomosis of the posterior wall of the stomach to the first part of the jejunum. The distal stomach had been partially resected. The proximal duodenum was buried in the pancreas. The transverse colon was firmly adherent to the gastro-enterostomy. After the stomach was opened a finger could be passed readily into the colon as well as into the small intestine.

Prior to 1903, 70 cases of gastrocolic fistulæ were reported, which had developed secondary to carcinoma of the stomach or of the colon. Haller (1) reported the first case in 1755 and Murchison (2) reported the first group, numbering 33, in 1857. In 1897 Bec (3) increased the group to 63, and in 1903 it was further increased to 70 by von Koch (4). The first case of gastrojejunocolic fistula was reported by Czerny (5) in 1903. This fistula followed the operation of gastro-enterostomy for gastric ulcer. The report appeared four years after Braun (6) had first described a case of gastrojejunal ulcer, in 1899. In 1921 Loewy (7) compiled from the literature a group of 76 cases of gastrojejunocolic fistula. By that time 185 instances of gastrocolic fistula of various types had been reported. In 1925 Verbrugge (8) compiled from the previous literature 202 cases of gastrocolic and gastrojejunocolic fistulæ. Seven among these had been reported from the Mayo Clinic. To these he added 14 cases from that Clinic. Of this total of 216, 95 had

followed upon a gastrojejunal ulcer, which had developed at a posterior gastro-enterostomy. The other 121 cases occurred in the course of primary abdominal disease. Since 1925, there have appeared in the literature 30 more cases, of which 22 occurred after gastro-enterostomy done for peptic ulcer and 7 from carcinoma of the colon or of the stomach. One was said to have been due to a "misadventure." Of the fistulæ following upon gastro-enterostomy, six were reported by Macdonald (9), three by Brock (10), and one each by Dejardin (11), Bradbury (12), Shangle and Beisler (13), Cabot (14), Kaufheil (15), Küttner (16), Wittkowsky (17), Robertson (18), Shore (19), Monroe and Emery (20), Pratt (21), and Lahey and Jordan (22). Of the fistulæ resulting from cancer, Brock (10), Hill (23), and Lambret and Razemon (24) each reported one, and Dickson (25) reported four, together with a case caused from a jejunal ulcer and another due to "misadventure," as mentioned above. The two cases of gastrojejunocolic fistula reported above occurred after gastro-enterostomy for duodenal ulcer and bring the number in that category up to 119, and the total of all types to 248.

Gastrocolic and gastrojejunocolic fistulæ, resulting from malignancy either of the stomach or of the colon, are becoming less frequent because of the earlier diagnosis of cancer. On the other hand, fistulæ following gastro-enterostomy have become more frequent. The chief factor in the etiology of the latter type of fistula is the occurrence of a perforation of a gastrojejunal ulcer, and the incidence is considerably less than that of these ulcers, which is given in the American literature (excluding the figures of Lewisohn) as from 2 to 5 per cent of all gastro-enterostomies, and in the German literature as from 5 to 10 per cent. They occur eleven times more often in men than in women, and Verbrugge found that of the

patients seen at the Mayo Clinic who had a gastrojejunal ulcer, 11.36 per cent developed a gastrojejunocolic fistula. Bolton and Trotter (26) found 10 per cent in a similar analysis and Lion and Moreau (27) 12 per cent.

The symptoms are fairly well represented in Case 1. Quite often, in addition to the diarrhea, cramping, and loss of weight, there is feculent eructation or vomiting. These symptoms vary in degree according to the size and directness of the fistula. The diarrhea may be of sudden onset in the course of a syndrome characteristic of marginal ulcer. The stools are liquid, contain undigested food, little mucus, and no pus or blood. They do not resemble those of colitis. However, one of the cases reported above was treated elsewhere upon that diagnosis. The absence of diarrhea does not contradict the diagnosis. Monroe and Emery (20) have reported two cases which were unusual in that neither had this symptom. The eructation or vomiting of fecal material varies with the directness of the opening, but is usually present in some degree. Pain is rare. The pain of the marginal ulcer is generally relieved after the fistula occurs, and may be replaced by a different, usually cramping, discomfort, lower in the abdomen than was the ulcer pain. The loss of weight varies and may be considerable in case the condition fails of early diagnosis and resultant starvation and dehydration continue.

The diagnosis may be made from these symptoms, together with the history of an antecedent gastro-enterostomy, with or without the symptoms of gastrojejunocolic ulcer, or with the history of malignancy of the stomach or of the colon. The diagnosis is confirmed—and when the symptoms are of minor degree it is made—by the roentgen demonstration of the opening between the segments. This may be difficult and inconclusive in case the tract is small and indirect, and it may be necessary to use a dye,

which, after ingestion with food, may appear promptly in the stool, or may be recovered by tube from the stomach when administered with an enema.

The treatment of the condition is surgical, the extent and nature of the procedure depending upon whether the segments are to be merely separated and closed, or the gastro-enterostomy, when present, be left, restored, or disconnected.

It appears evident that the factors which allow the development of a gastrojejunocolic fistula are those of the origin of the marginal ulcer. These may be enumerated as (1) carelessness in post-operative management; (2) causes similar to those of the original peptic ulcer; (3) the use of unabsorbable sutures; (4) trauma of the mucosa at operation, and (5) an inadequate position and patency of the stoma. Undesirable circumstances in the manner of treatment of the transverse mesocolon in performing a posterior gastro-enterostomy should be considered among the factors both of the marginal ulcer and of these fistulæ. The fistulous opening into the colon is a fortuitous occurrence in the penetration and perforation of the marginal or jejunal ulcer, and is classified according as the stomach and jejunum are separately or jointly involved in the opening. The communication may be so direct that there is scarcely any appreciable fistulous tract. This was the condition in the first case reported. On the other hand, the communication may be small and intermittently patent or have a valve action. This situation lessens the characteristic symptoms and makes the diagnosis of the condition more difficult.

#### SUMMARY

1. Two cases of gastrojejunocolic fistula following gastro-enterostomy for duodenal ulcer are reported.

2. The literature has been reviewed and 30 cases of gastrocolic fistula collected, of

which 22 were gastrojejunocolic in type, following upon a gastro-enterostomy for peptic ulcer.

3. The condition may remain unrecognized, as in the second case, and may be susceptible to most successful treatment, as in the first.

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## RIGHT DIAPHRAGMATIC HERNIA<sup>1</sup>

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THE patient whose case report introduces this paper was a female 72 years of age, who was admitted to the hospital on Dr. Sansum's service, complaining of obesity, constipation, and rheumatism. Her history was negative for trauma. She had undergone a cholecystectomy at the age of 52 and had gone through nine normal pregnancies.

Physical examination showed dullness over the right lower chest, with absence of breath sounds over this area. During fluoroscopy incidental to an orthodiagram an enlarged heart was noted and a shadow seen in the right lower chest. She was referred to the Roentgen Department for chest study. This showed a moderate left ventricular enlargement, with a dense shadow in the lower half of the chest. The heart was displaced slightly to the left. No respiratory excursion could be seen on the right side. The upper zone of the shadow showed an air-containing viscus, and on the chance that this might represent gas-containing loops of bowel a barium meal was given to rule against a diaphragmatic anomaly (Fig. 1).

An intrinsically sound normal stomach and cap were visualized. The pyloric portion of the stomach and the duodenum were seen to be lower than the usual position in a patient of this habitus. The cap was large and flaccid, instead of being of the small round or flat type usually seen in stout patients (Fig. 2).

Twenty-four hours after the barium meal the head of the column was in the descending colon and the tail in the cecum. The entire hepatic flexure, including most of the transverse colon, was seen to lie in the right

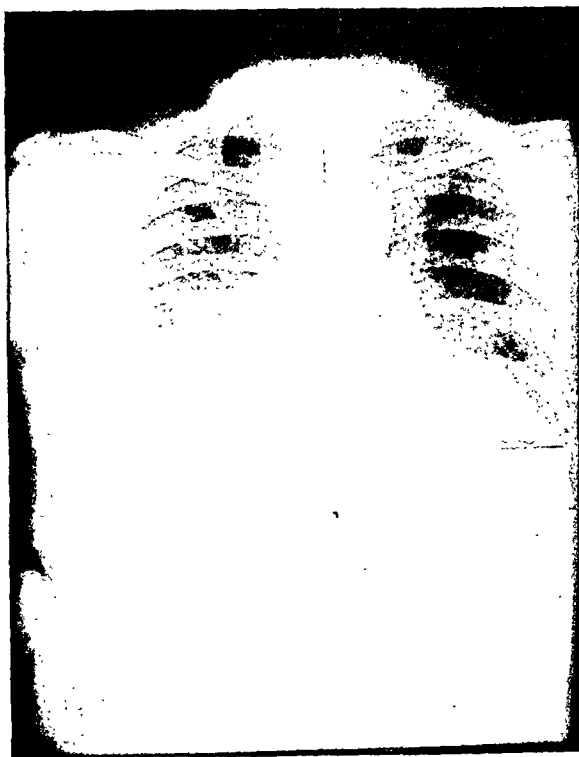


Fig. 1. Roentgenogram showing a high diaphragm and gas-filled loops of colon.

thorax, extending up to the level of the second rib anteriorly. Except for its position and a few diverticula, the colon was normal (Fig. 3). The tip of the cecum was seen to lie a few centimeters above the iliac crest. The ascending colon entered the thorax just to the right of the esophageal hiatus. No connection with this foramen could be observed either on films or by watching barium pass into the stomach while the colon still contained barium.

The heart film showed what was possibly a thin septum at the upper margin of the shadow, but films made after the colon was filled with barium failed to show evidence of this being the diaphragm. We concluded, therefore, that the wall of the colon, which contained a small amount of gas at

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.



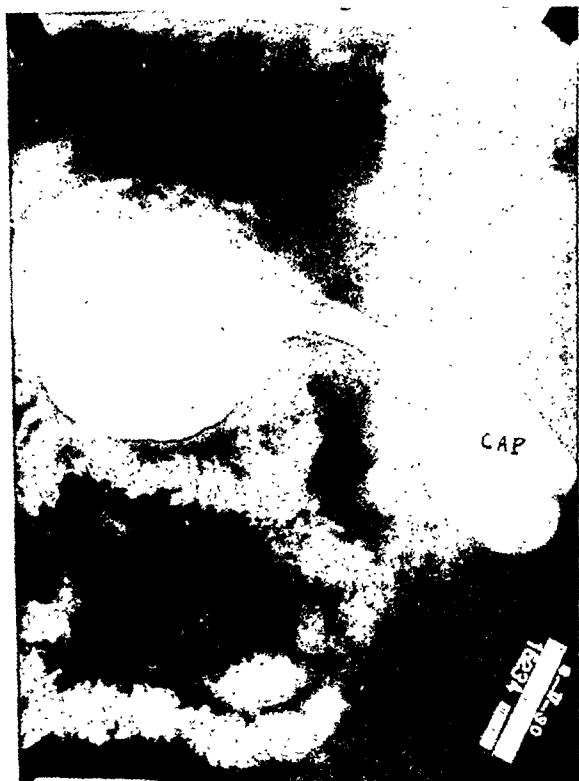


Fig. 2. Roentgenogram showing filled stomach and cap after the barium meal.

the first examination, accounted for this shadow. The condition was, therefore, regarded as a hernia rather than as an eventration of the diaphragm. Furthermore, the upper level of the shadow lacked the characteristic bow-shaped contour seen with eventration.

Anomalies of the diaphragm consist of eventration and hernia. In eventration, the diaphragm is abnormally high in level, due to either congenitally aplastic or acquired atrophic muscle fibers. Various writers have designated this condition by different terms, such as relaxation, insufficiency, high position, or dilation.

Hernia of the diaphragm is either congenital or traumatic in origin. Both hernia and eventration are seen much more commonly on the left side. Of various statistical summaries, Eppinger reports 626 left-sided hernias as compared to 8 on the right side. Thomas, in his review, found 8 right



Fig. 3. Roentgenogram taken 24 hours after the barium meal, showing barium-filled colon in chest.

and 282 left. Twenty cases have been reported from the Mayo Clinic, 17 on the left side and 3 on the right.

Of a series of 17 cases reported by Carman and Fineman, one presents a remarkable similarity to the case I have just shown. Their patient was a woman 47 years old, who had suffered vague abdominal distress for years. They reported as follows: "A roentgenogram of the chest revealed gas bubbles above the right diaphragm and an opaque enema showed herniation of the colon through a large opening in the right diaphragm. At operation the transverse colon and omentum were found herniated into the chest. The hernial opening, 8.75 cm. in diameter, was found in the middle line posterior to the attachment of the diaphragm to the sternum. The patient's recovery was uneventful."

LeWald reported a very similar case in which operation showed the colon to enter the thorax behind the liver. In his case a

portion of the duodenum was above the diaphragm.

The type of case with herniation of the large bowel presents an entirely different picture from that of the right diaphragmatic hernia of the short esophageal type. Fineman, in describing a case, remarks that this type strongly simulates the appearance of walled-off fluid in the right lower chest.

The roentgen diagnosis of hernia or eventration of the diaphragm is not difficult if the condition is kept in mind during the routine examination of chest films and gastrointestinal cases. The differentiation between hernia and eventration is not so easy in some cases and may be impossible by the roentgen examination. Pneumoperitoneum may be useful as a differential aid if a barium series does not complete the necessary evidence. When, as was found in the case here reported, the upper zone of the shadow shows gas-containing loops of bowel, an absence of a bow-shaped diaphragmatic shadow, and the condition on the right side, the diagnosis of hernia can be made from chest films.

The literature contains reports of a considerable number of eventrations and hernias which have been explored with an aspirating needle. Truesdale reports one case where an exploratory chest puncture showed milk which the patient had drunk a short time before. The danger of this error is obvious and such errors can be avoided if the possibility of diaphragmatic anomaly is kept in mind.

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Fig. 4. Roentgenogram taken 48 hours after the barium meal.

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# A NEW DIAPHRAGM FOR THE COMPLETE ELIMINATION OF SECONDARY RADIATION

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THE abolition of secondary radiation has been one of the most perplexing problems confronting radiologists. The Bucky-Potter diaphragm, notwithstanding its great merits, solves only a few of the problems concerning elimination of secondary radiation. The limitations of the Bucky-Potter diaphragm are so well

known to roentgenologists that we do not even attempt to mention them.

The writer wishes to present a new diaphragm, the usefulness of which is not limited to any special technic, but which can be used for every purpose in all kinds of radiographic or radioscopic investigation, fulfilling all the desiderata of the radi-

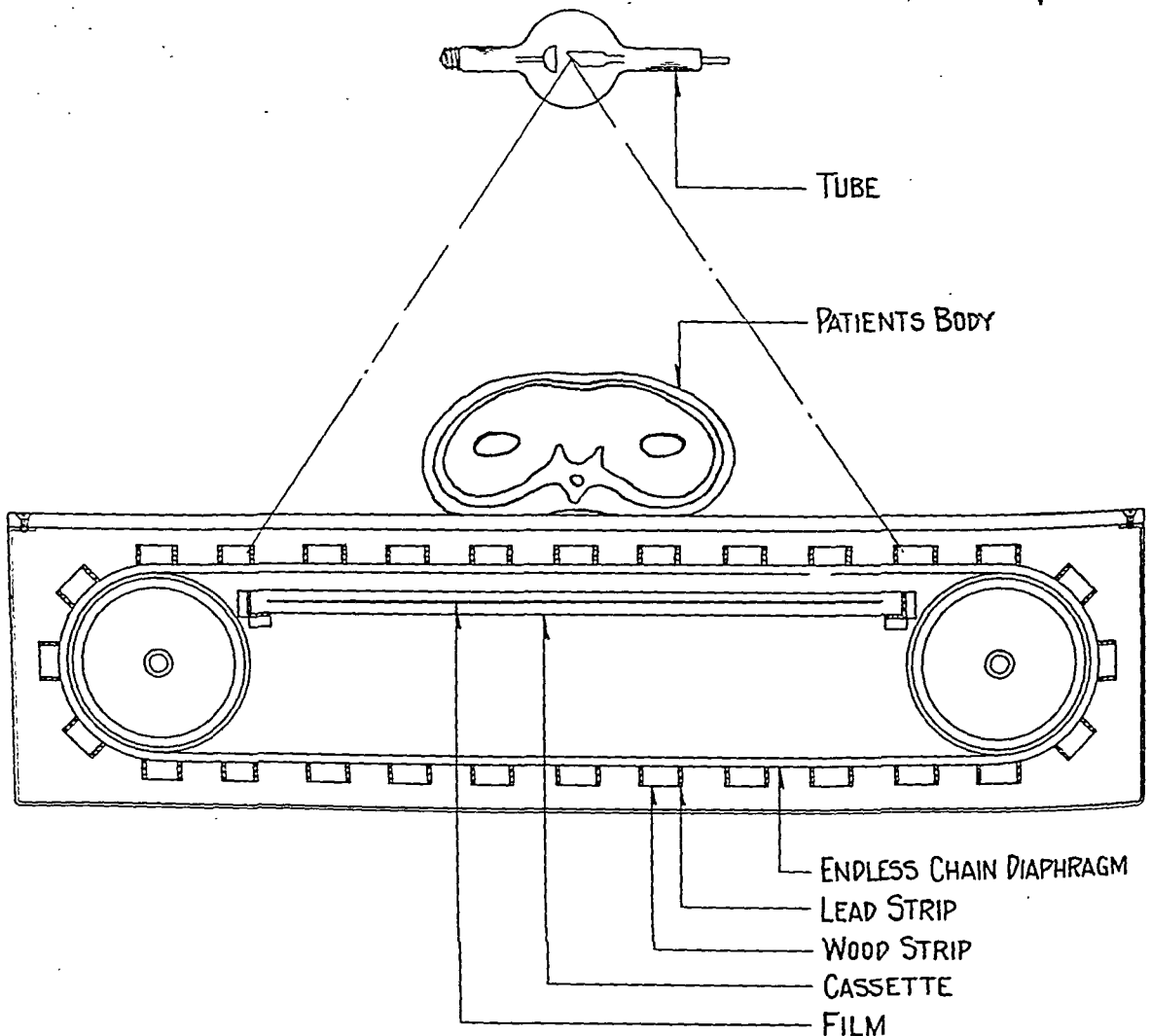
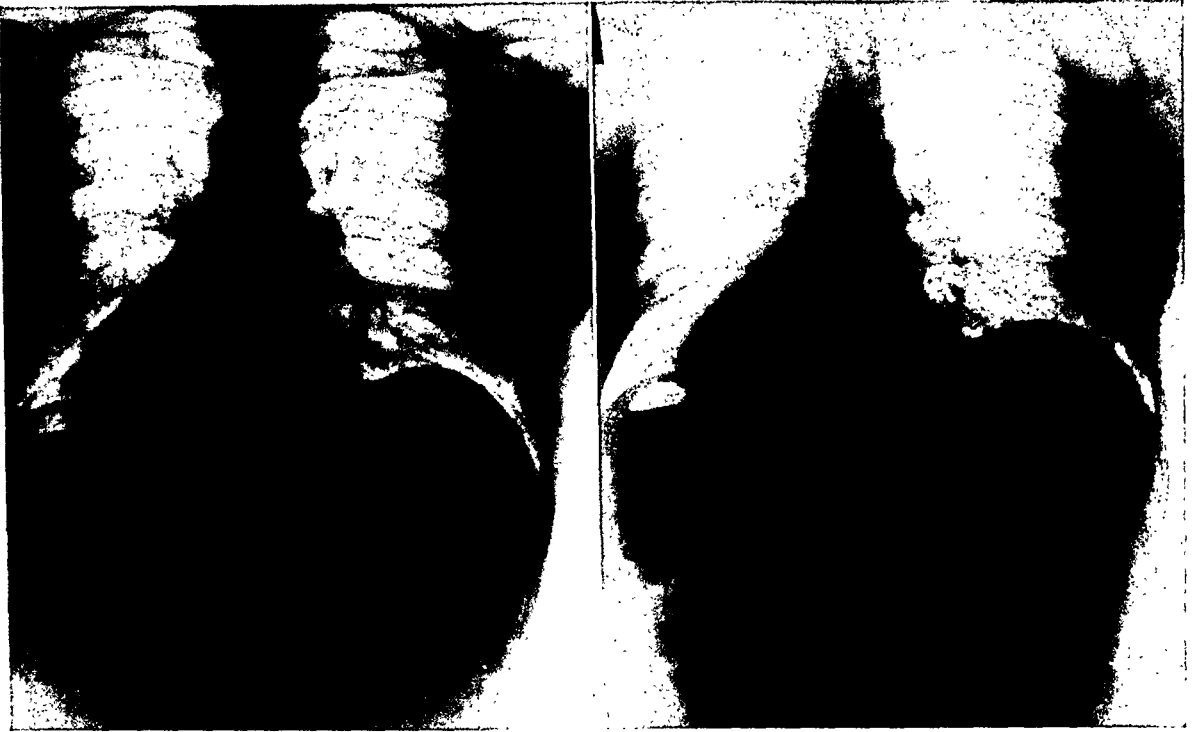


Fig. 1. Drawing of Soresi diaphragm.



Figs. 2 and 3. Chest of a heavy man. Both films were taken at 2 meters, one-tenth of a second exposure, with the same cassette. They were developed at the same time. All radiographic factors were exactly alike in these films, except that Figure 2 was taken with the Soresi diaphragm and Figure 3 without a diaphragm.

ologist. The author's diaphragm has the following characteristics:

1. It eliminates effectively secondary radiation.
2. It does not increase the time of exposure.
3. It can be used at any focal distance.
4. It allows the taking of radiographs at any speed with a sharpness of detail hitherto unknown.
5. It does not leave grid marks on any part of the film.
6. It is used also for fluoroscopy, making this procedure more useful by clearing considerably the image on the fluorescent screen.
7. It works independently from the X-ray tube.
8. It makes soft tissues very clear and distinct.
9. It works in any position.



Fig. 4. Radiograph of a young woman, 27 years of age, with goiter; normal trachea.



Fig. 5. Carcinoma of larynx, extending to trachea. Note infiltration of tissues revealed by the X-rays. Distance, 72 inches; time, one-tenth of a second.

10. It can be used for all kinds of radiographic or fluoroscopic work.

We shall not enter into details of construction, which may vary with further experience and the requirements of manufacturing.

The fundamental principles on which our diaphragm is based are: (1) the lead strips are not parallel to the rays emitted by the tube; (2) the lead strips move at a tremendous speed independently of the X-ray tube; (3) the high speed at which the diaphragm moves is made possible by arranging the lead strips on an endless chain put in motion by a suitable electric motor. Physicists and radiologists may look upon these claims with skepticism. In fact, in discussing the conception of this diaphragm with leading men, nothing but the words "impossible," "contrary to physical principles," *et similia* were heard. However, skepticism was turned to praise, at times

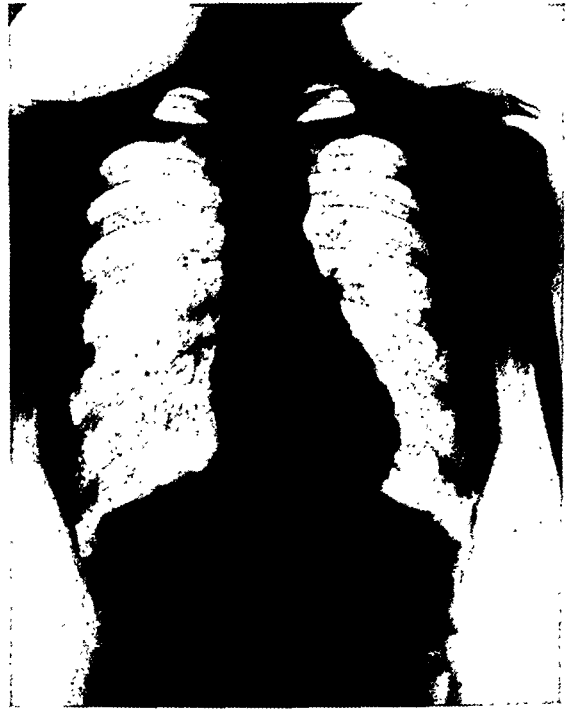


Fig. 6. Chest, at 72 inches; exposure, one-tenth of a second.

even above merits, when the diaphragm was demonstrated in actual radiography and radioscopy.

The writer's diaphragm works with absolute independence of the X-ray tube. It is set in motion, whether for fluoroscopy or radiography, and the current is passed through the tube when and as long as desired independently, and is timed by the usual apparatus.

The *modus operandi* is simplicity itself: films are placed in a channel located behind the diaphragm, which is then set in motion. The exposure is made by pressing the button of the timer, as is done when exposures are made at present without a diaphragm, the timer alone controlling the time of exposure.

#### FOR FLUOROSCOPY

The fluorescent screen is applied against the cover protecting the lead strips, the patient being in front. The diaphragm is set

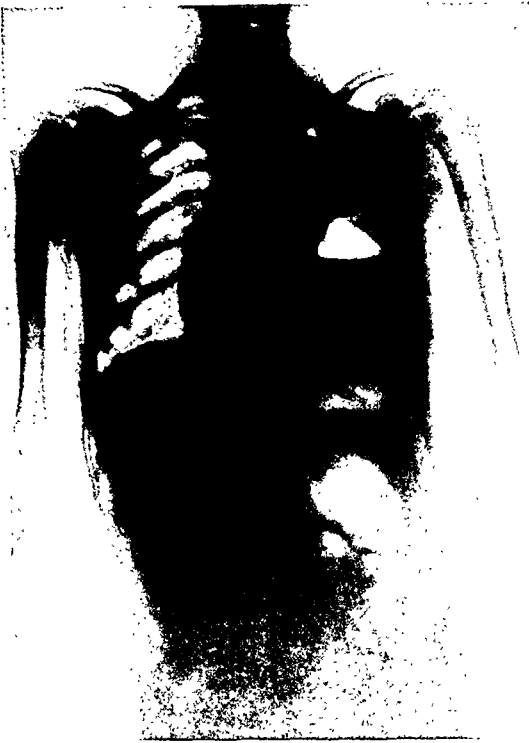


Fig. 7. Chest of a child, 6 years old, with pneumo- and pyo-thorax, at 72 inches; exposure, one-twentieth of a second.



Fig. 8. Carcinoma of esophagus in the middle third. Note how the tissues infiltrated by malignant cells stand out clearly. As in all other illustrations, the reproductions must of necessity fail to give the richness of detail shown in the original films. Distance, 72 inches; time, one-tenth of a second.

in motion and the current passed through the tube in the ordinary manner. Observation on the fluorescent screen is made through the double layer of lead strips and is exceedingly clear.

Special apparatus is in process of construction for combined fluoroscopy and radiography.

We have taken films of the digestive organs (stomach, gall bladder, colon, liver, spleen) all on one film, at about forty-five inches in three-tenths of a second, and of the chest, trachea, and esophagus, at seventy-two inches in one-twentieth of a second. Some of the radiographs are reproduced as illustrations in this paper, though it is an understood fact that reproductions fail to give the true impression one receives from the original films. The films taken with this diaphragm have a brightness and a

lively character, lacking in films taken without the diaphragm described. Special mention should be made of soft-tissue revelation. The trachea, the epiglottis, the contour of tumors of the esophagus through the mediastinum, hairs, as well as silk and linen tissues and threads become plainly visible on the film.

We believe that this new diaphragm has a broad field of usefulness. The fact that it does not increase the time of exposure makes possible the elimination of secondary radiation on instantaneous films, thus giving them a most remarkable clearness of detail. The fact that it can be used at any focal distance allows elimination of secondary radiation on films at any focal distance, thus allowing clearer films of the chest at 72 inches or of the dense abdominal organs at 30 inches. The fact that it does not increase

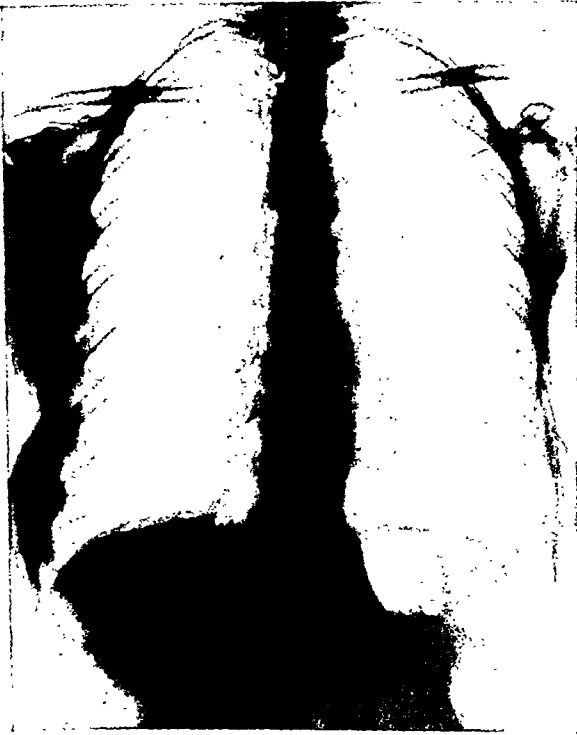


Fig. 9. Same case as shown in Figure 8, anteroposterior view. Note how the growth is shown through the mediastinum. Distance, 72 inches; exposure, one-tenth of a second.



Fig. 10. Skull taken at 72 inches; exposure, one-twentieth of a second.

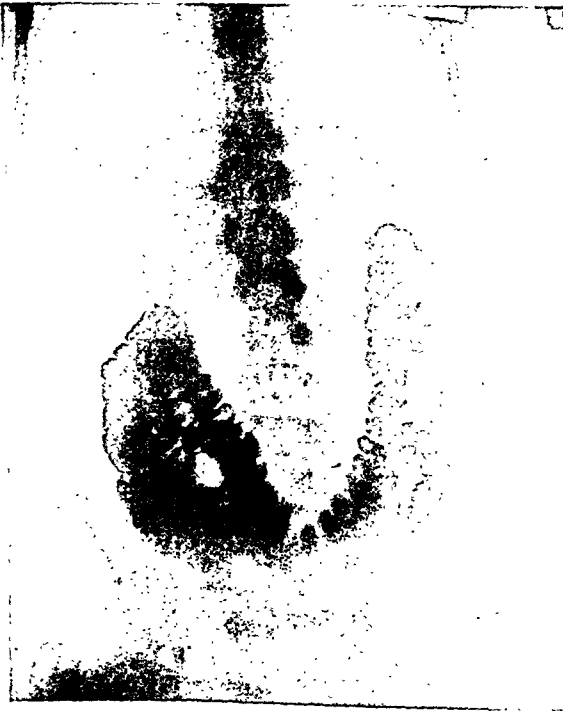


Fig. 11. Gall bladder and colon taken at 40 inches; exposure, four-tenths of a second. In the original film the spleen, the liver, and the right kidney are plainly visible.



Fig. 12. Same case as shown in Figure 11, with the barium meal in the stomach.

the time of exposure makes radiography and radioscopy safer for patients, attendants, and tubes.

In conclusion, the writer hopes that the rapidly moving diaphragm herein described, with its unique features of abolishing secondary radiation while not increasing the time of exposure; its adaptability to any

focal distance, to any speed, to any position, to both radiography and fluoroscopy, will be of help to radiologists.

The writer wishes to acknowledge the intelligent co-operation of the staff of the Westinghouse X-ray Co., Inc., and especially of Mr. Wappler, Mr. Fayer, and Mr. Larson.

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The Relationship between Radiology and Medicine. Wright Clarkson. Virginia Med. Monthly, August, 1930, LVII, 298.

The value of roentgen diagnosis is so striking that hundreds of physicians are succumbing to the lure of the manufacturers and are buying X-ray equipment without an adequate conception of the science of radiology. No branch of medical science requires more profound and prolonged study to master than that of radiology, because it extends into every phase of medicine, and the radiologist becomes a consultant in every specialty of practice. Most radiologists have no patients of their own but work purely as consultants, and as such should help correlate their findings with the clinical history and other data in actual

consultation with the referring physicians or surgeons.

W. W. WATKINS, M.D.

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Sources of Danger in Superficial Therapy. Dezsö v. Kémeri. Strahlentherapie, 1930, XXXVIII, 187.

The author observed that inaccurate readings of the milliamperemeter are quite common, due to electrostatic changes. The moisture of the room has great influence on this phenomenon. It appears that at a room temperature of from 15 to 20 degrees centigrade, a drop of the hygrometer from 40 to 35 degrees may lead to a difference in the dose up to 120 per cent. This fact should be considered more carefully in medico-legal cases.

ERNST A. POHLE, M.D., Ph.D.



# THE POST-OPERATIVE BEHAVIOR OF THE DIAPHRAGM<sup>1</sup>

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SIX months ago it was determined to investigate some phases of post-operative chest complications by means of X-ray examination. The practice of making bedside X-ray examinations before and after operation was begun.

To date, the series of cases which have been radiated includes high and low abdominal operations, herniotomies, kidney

dium applied to the cervix uteri, breast amputations, and operations upon the feet.

The anesthetics given to this group included local, spinal, rectal, ethylene, nitrous oxide and oxygen, and ether. Primarily the search was intended to be made for unsuspected atelectasis, and, in spite of the fact that our series of examinations thus far has been accomplished in the late Spring,

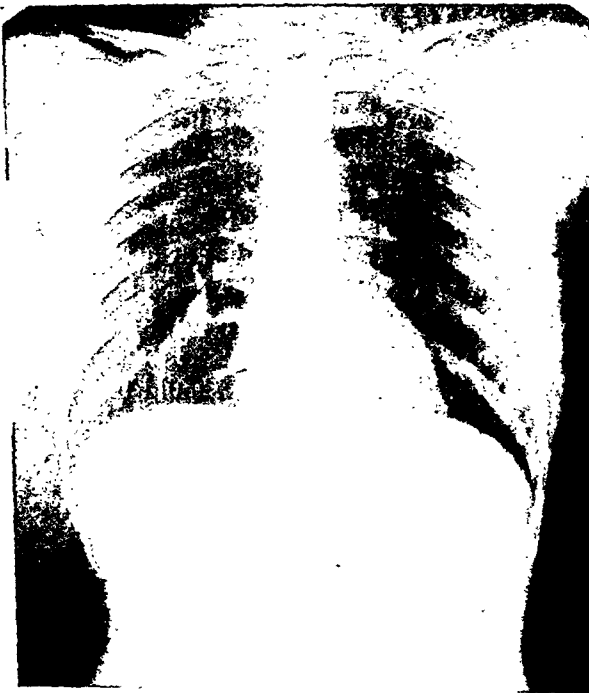


Fig. 1-A. Demonstration of effect of variation of technic in the level of the diaphragmatic domes. Bedside patient. Back flat on cassette. Cf. Fig. 1-B.

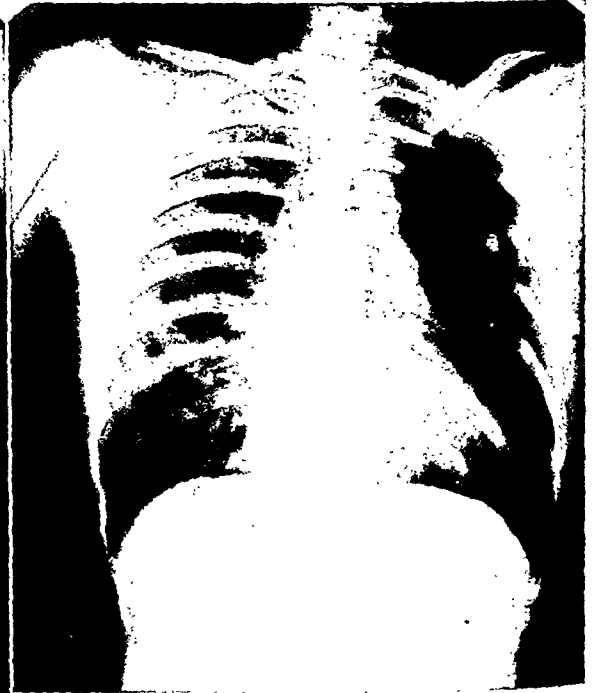


Fig. 1-B. Same case as shown in Figure 1-A. Right side purposely rotated forward to a marked degree. Tube-to-plate relationship remains the same. This "error" in technic does not affect the relative height of the domes of the diaphragm.

operations, thyroid operations, perineal repair, curettements, hemorrhoidectomies, one submucous resection, two cases of ra-

Summer, and early Fall months, during which seasons chest complications are at a minimum in Colorado, we have found a considerable number of cases of atelectasis which would have passed unrecognized. The

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

study will continue throughout the Winter and early Spring (17).

Many other interesting types of unsus-

pared to their relative shape and position before operation. (See Figs. 8-A, 8-B, 9-A, 9-B, 9-C, 10-A, and 10-B.)

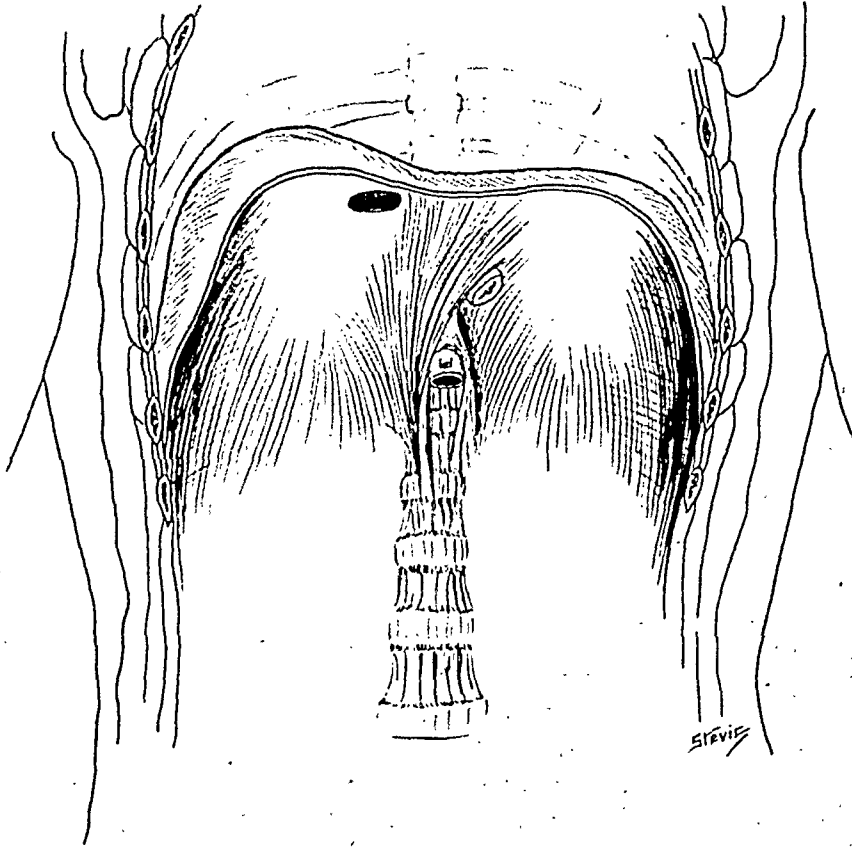


Fig. 2. Under surface and cut anterior edge of the diaphragm. Note how much lower the origin is than the insertion (central tendon in the dome). See text.

pected chronic and acute chest pathology have been revealed in the series. These will be described in another paper.

Early in the study it was noticed that in many instances (54 out of 94 cases) both diaphragm domes maintained a higher position immediately after than before operation. It was not long after this condition had manifested itself that an occasional case presented an asymmetrical relationship between the shape and position of the two hemidiaphragms after operation, when com-

This paper will confine itself essentially to that portion of the study which deals with the post-operative asymmetry of the diaphragmatic domes. A consideration of the relationship of this condition to atelectasis by the writer of this article may be found in a previous paper on the subject of post-operative chest complications (9).

Thirty-six cases out of 94 (the total number studied to date) have shown a sharp arching and high position of the right hemidiaphragm, and five cases have shown a

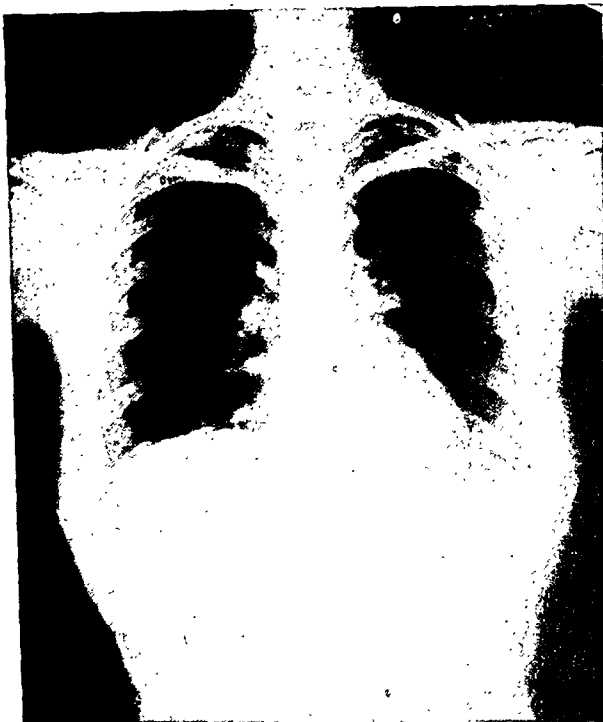


Fig. 3-A. Pre-operative X-ray examination. Cf. Fig. 3-B.



Fig. 3-B. Two days post-operative examination of same (low abdominal) case as shown in Figure 3-A, made at full inspiration. Both domes are high, with superimposed additional ascent of the right hemidiaphragm. The heart is forced to a horizontal position, extending more to the right of the spine than in the pre-operative plate. Collateral lung clear. See text.

similar situation of the left half of the diaphragm, with no X-ray or clinical evidence of disease of the collateral lung.

The affected hemidiaphragm is found to have assumed a high position when examined the day after operation, and as a rule it gradually subsides to the pre-operative position and shape when visualized at inspiration by the same technic as at the first examination, in a week or ten days. In some instances the affected dome was still high three weeks later. A few have subsided markedly in three or four days.

Many cases show both hemidiaphragms to be high after operation, with one asymmetrically higher than the other. This causes the heart to assume a more horizontal position and thus may cause it to encroach farther on the side of the higher diaphragm than it did in the pre-operative plate. This combination gives a strong impression of atelectasis, and it was at first thought that these findings, in the absence of visualized

density of the lung, were the result of an atelectasis which, perhaps, was obscured behind the dome in the posterior sulcus, but lateral X-ray plates and close clinical observation have disproved that conception. Brunn and Brill (15) illustrate a paper<sup>2</sup> with a typical case of asymmetrically high hemidiaphragm which they attribute to a minor degree of atelectasis, yet the lung field is clear. Our series of cases have led to the belief that this condition may precede and contribute to atelectasis.

After this phenomenon had been repeated in several patients, the recent literature was reviewed and reference found to a symmetrically high position of both diaphragmatic domes following abdominal operations

<sup>2</sup>This article was noted just prior to the final typing of this paper.

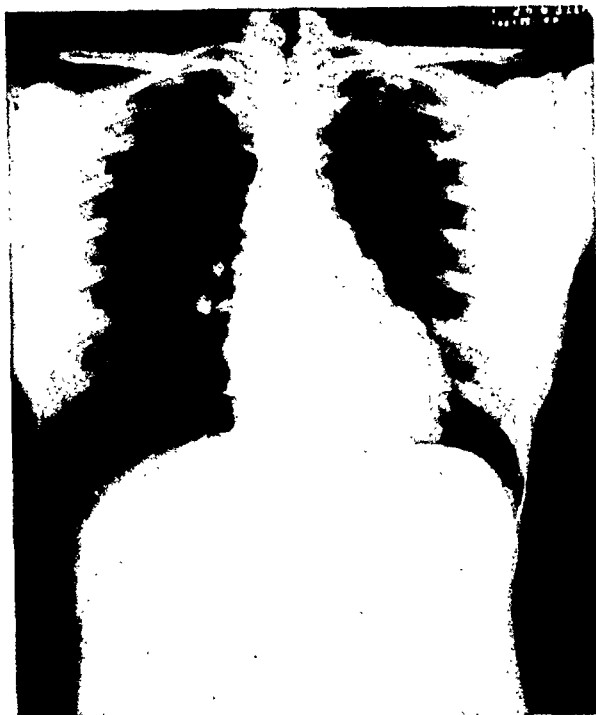


Fig. 4-A. Pre-operative plate of a nephropexy case. Cf. Fig. 4-B.



Fig. 4-B. Same case as shown in Figure 4-A, two days post-operative. Not only is the right hemidiaphragm high with no evidence of atelectasis above, but there is marked bilateral ascent of both diaphragms with hypoventilation of both lungs. Note left kidney incision clips and large amount of abdominal gas. See text.

(5, 8) in several smaller series of cases, but attention was not called to a high position of one side only. The nearest approach to a mention of this condition, except as a sign of atelectasis, which I have found was by Sise, Mason, and Bogan (12). They state that ten cases of gall-bladder surgery radiated before and after operation showed a marked diminution of *excursion* in both leaves of the diaphragm, with the greater effect on the right.

We concur with Muller (7) that the bilateral post-operative high position of the diaphragm can possibly be explained without much consideration of hypotonus, paresis, or partial paralysis. The one-sided high position, however, seems to require serious consideration of possible nerve inhibition or paralysis of varying degree.

Most chest complications, especially atelectasis, occur unilaterally, and more on the right side than on the left, and more often in the lower lobe than in the upper. The

high diaphragm finding occurs much more often on the right, and would, of course, have more effect on the lower lobes than on the upper lobes.

Because of these considerations the subject is deemed sufficiently important to warrant the presentation of our observations thus far and the venture of interpretation. It therefore becomes the purpose of this paper to describe and interpret these X-ray manifestations and to allude to the cause, hoping that a little evidence may be added to the rapidly accumulating data on the subject of post-operative chest complications.

#### RADIOGRAPHIC TECHNIC

Because we were studying the difference in the relative position of the two diaphragmatic domes, and not the position of

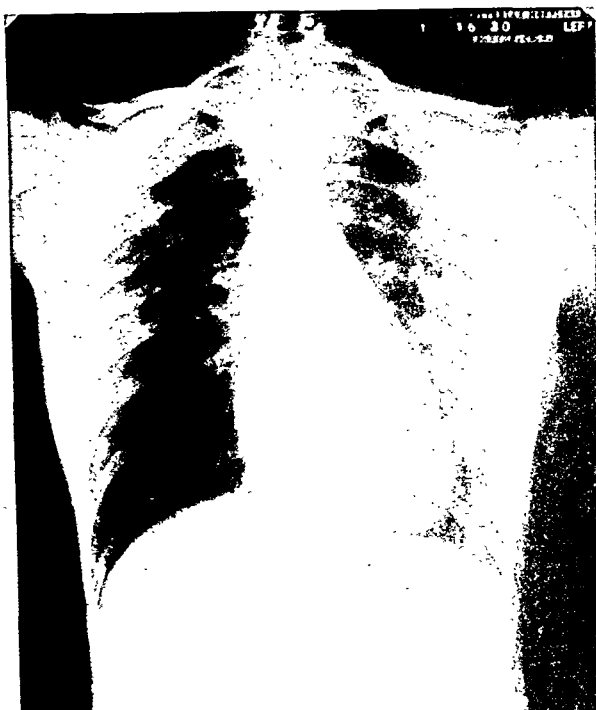


Fig. 5-A. Pre-operative chest roentgenogram. Cf. Fig. 5-B.



Fig. 5-B. Same case as shown in Figure 5-A. Some asymmetrical ascent of the right hemidiaphragm. Note that air admitted by abdominal operation has sought only the right subdiaphragmatic area. See text. Note also the sharper outline of the high dome as compared with the opposite side and the same dome prior to operation.

either one as measured from a bony landmark, variance in the target-to-plate distance and angle at which the patient was raised made no appreciable difference in the findings. This was demonstrated by making two or more examinations on the same patient, each with different technic. Even when the patient was turned with one side farther from the plate than the other, the diaphragmatic domes were not changed in their relative height (Figs. 1-A and 1-B).

Some of the earlier cases of the series were examined pre-operatively at the erect chest plate changer, followed by post-operative bedside plates. This did not interfere with the results in any case. The majority of the cases, however, were radiated in bed with exactly the same technic before and after operation, the beds being brought to the radiographic room. The central ray was passed through the ensiform at right-angles to the plate, 46-inch distance, 100 milliamperes, one-tenth second, and the kilovoltage

variable. Every effort was made to reproduce after operation the technic employed before. All patients were asked to take as deep a breath as possible and hold it during the exposure.

We hope as we continue our study to make more examinations in the lateral position. They are valuable to other phases of the work but probably will not add much evidence to the problem discussed in this paper.

#### ANATOMY

A glance at Figure 2 to refresh our memory of the anatomy (1) of the diaphragm, reveals that its origin, which is on the lower five or six ribs, upper three or four lumbar vertebrae and ensiform, is lower than the insertion, namely, the central tendon



Fig. 6-A. Pre-operative roentgenogram (exposure too light to penetrate breast shadows and bases). Cf. Fig. 6-B.

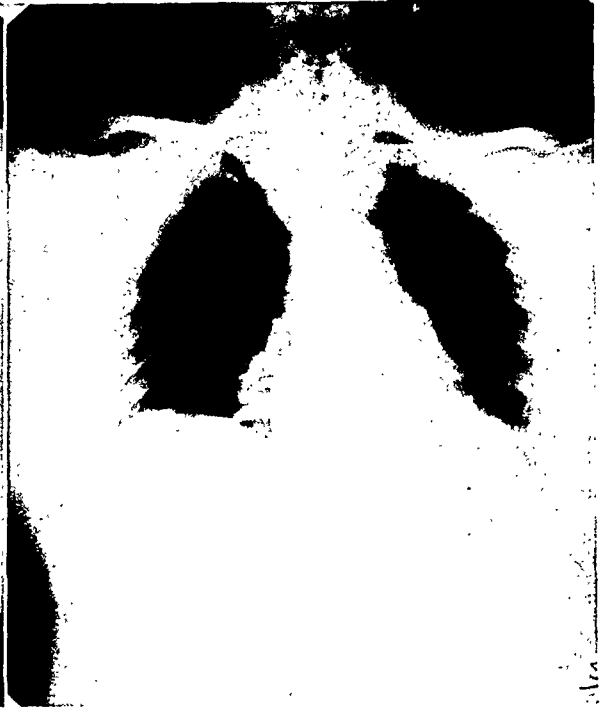


Fig. 6-B. Same case as shown in Figure 6-A, one day post-operative. Note change in relative position of the domes of the diaphragm with no demonstrable right lung disease. Note narrowed interspaces on the right. See text.

which is practically the highest part of each hemidiaphragm. Contraction must cause the arched dome to descend and flatten. Relaxation or paralysis permits ascension and arching. This is demonstrated physiologically by inspiration (contraction) and expiration (relaxation), respectively. This fact is further demonstrated, pathologically, after the operation of phrenico-exeresis.

The diaphragm is merely a thin membrane-like partition fastened loosely across the thoraco-abdominal cavity. Atmospheric pressure on the flaccid-walled abdominal portion of the cavity keeps the thin hemidiaphragms ballooned upward into the rigid-walled thoracic cavity (3). Contraction works against this abdominal pressure and causes flattening and descent of the domes: relaxation permits them to passively ascend and arch.

#### DISCUSSION

It is logical to believe that the more con-

stant post-operative findings of bilateral high position of both hemidiaphragms and the less common phenomenon of one dome arching to a higher position after operation than its position relative to the opposite dome before operation, are not existent from the same causes.

Two main causes of the bilateral symmetrically raised diaphragm present themselves. The first to be thought of is that pain occasioned by deep breathing will prevent the patient from inspiring as fully after operation as before. The other most tenable cause is an increase of intra-abdominal pressure, caused by accumulating gas, which forces both domes upward. (See Figs. 3-A and 3-B.)

Abdominal and many other major operations are attended with post-operative pain when the patient inspires deeply (6). This prevents him from taking as deep a breath when radiated after operation as at

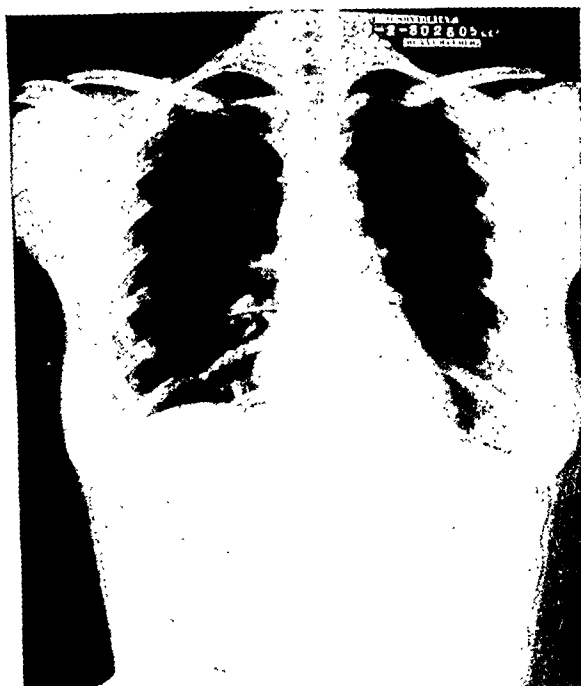


Fig. 7-A. Pre-operative X-ray examination. Right hemidiaphragm normally a little above the left one. Cf. Figs. 7-B and 7-C.

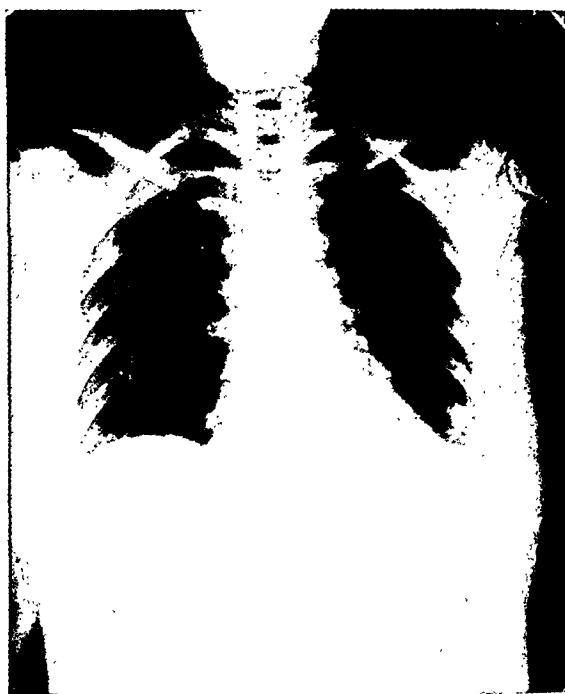


Fig. 7-B. Same case as shown in Figure 7-A, two days post-operative. Note that the domes are now of equal height, probably indicating asymmetrical ascent of the left hemidiaphragm. Cf. Fig. 7-C.

his X-ray examination prior to operation. Table I exhibits statistics which strengthen this opinion. It will be noted that abdominal

operations, kidney operations, perineal repair, and thyroidectomies show the highest incidence of bilateral raising of the dia-

TABLE I

OCCURRENCE OF ASYMMETRICAL HIGH HEMIDIAPHRAGM NOTING ALSO NUMBER OF BILATERAL CASES

Type of operation	No. of cases	Unilateral high diaphragm		No. of cases of bilateral ascent of diaphragm
		No. of cases	Percentage	
Herniotomy	4	3 (all right)	75%	2
High abdominal	13	9 (8 right; 1 left)	61%	8
Kidney	10	6 (5 right; 1 left)	60%	7
Low abdominal	34	12 (11 right; 1 left)	47%	16
Uterine curettage	5	2 (1 right; 1 left)	40%	0
Hemorrhoid	3	1 (right)	33%	0
Thyroid	15	3 (2 right; 1 left)	20%	7
Breast (amputation)	3	0	0%	0
Perineal	2	0	0%	2
Foot operations	3	0	0%	1
Radium to cervix	2	0	0%	0
Submucous resection	1	0	0%	0

phragm following operation. These types of operative procedures cause the most post-operative pain upon deep breathing.

Patey (6), Head (8), and Oberholt (16)<sup>3</sup> measured the vital capacity (the total volume of air obtained from a maximum expiration following a maximum inspiration) before and after abdominal and other operations. Following operation there was a smaller vital capacity than before. The abdominal operations caused the greatest discrepancy.

Evidence upholding the abdominal gas factor as a cause was found in a study of serial X-ray examinations of new born infants<sup>4</sup> beginning immediately at birth with plates, made at varying intervals up to ten days, on file with the Child Research Council of the University of Colorado Medical School. It was noted that as air was ingested first into the stomach and then into the small and large intestine, the hemidiaphragms gradually ascended in relation to the increase in the amount of air and fermentative gas. Unilateral disposition of the gas caused symmetrical upward displacement of both sides of the diaphragm. In none of the cases reviewed was there an asymmetrical upward displacement of the diaphragm. Further evidence supporting abdominal gas as a cause of bilateral symmetrical raising of the diaphragm is furnished by some adult cases in our present series, which show one-sided accumulation of gas (Figs. 3-A and 3-B) accompanied by a symmetrically high diaphragm.

Pressure in the abdomen apparently follows the law of pressure on liquids, namely, that it is exerted equally in all directions. This is graphically demonstrated in the paradoxical movement with respiration of a phrenicectomized hemidiaphragm. Pressure downward on the abdominal contents by the



Fig. 7-C. Same case as shown in Figures 7-A and 7-B, fifteen days post-operative. Right hemidiaphragm again higher than left, as in the pre-operative plate. Left dome has subsided.

normal side is transmitted as though by a liquid medium to the passive side.

Muscle splinting in abdominal cases may exaggerate the pressure caused by the increasing gas.

The presence of bilateral paralysis as a cause is obviated by the lack of symptoms. Whereas paralysis of one hemidiaphragm may have very slight symptomatology because, as Andrus and Wilson (11) tell us, there is reduction of only one-sixth to one-third of tidal air rate and respiratory volume, which is quickly compensated for by the other lung, bilateral paralysis, on the other hand, reduces tidal air volume by 60 per cent and respiratory volume by 62 per cent. The bilateral high diaphragm was found in too many cases of uneventful and symptomless recovery to permit of suspecting paralysis as a cause even in degrees less than complete.

The statistics of our series further indicate that the causes of unilateral rise are

<sup>3</sup>Published after this paper had been typed.

<sup>4</sup>The writer wishes to thank Dr. W. W. Wasson for the suggestion that he review these cases.



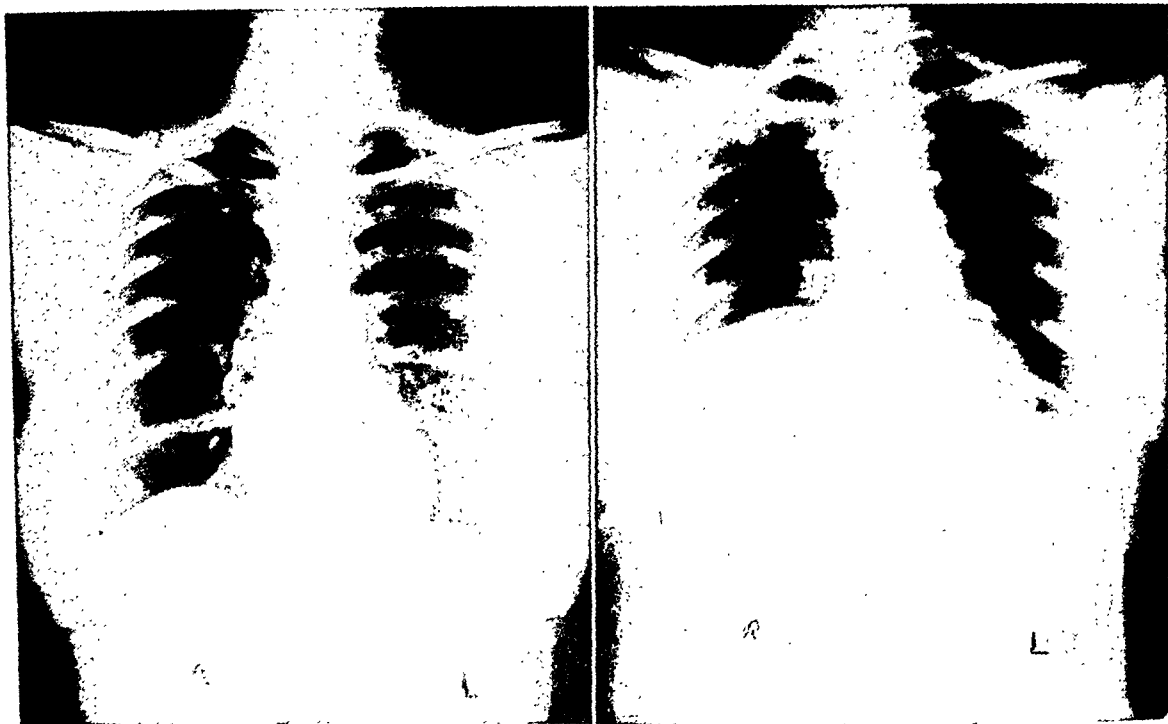


Fig. 8-A. Pre-operative plate. Cf. Fig. 8-B.

Fig. 8-B. Same case as shown in Figure 8-A, one day post-operative. No density indicating atelectasis of sufficient extent to require this much diaphragmatic ascent. No clinical indication of lung pathology.

different from those of bilateral high position. There were at least eight of the former not accompanied by the latter condition and at least ten of the latter type of cases not accompanied by asymmetrical high diaphragm.

Explanation of the high position, following operation, of *one* diaphragmatic dome is not so manifest. Thus far we have been unable to evolve an explanation without resorting to the idea of at least a partial paralysis.

After studying the ninety-four cases in this group there can be no doubt but that in a certain number of operative cases one dome of the diaphragm assumes an abnormally high position *in relation to the opposite dome*, without X-ray or clinical evidence of collateral lung disease.

Each case has been carefully measured to establish the relative position of the two domes. Unless a change of 1 cm. or more was present, the case was not included in

the statistics. In many cases of one-sided post-operative rise, the opposite dome had also mounted after operation by virtue of the causes of bilateral post-operative rise, so that most of the measurements of one-sided ascent of from 1 cm. to 4.5 cm. are in excess of the bilateral ascent, which apparently varied from 1 to 4 centimeters. (See Figs. 4-A and 4-B.) (Error in measurement of the ascent of both diaphragms in relation to the spine or other bony landmark could be caused by variation of technic; therefore, the figures of these measurements are not presented.)

Asymmetrical action of the diaphragm precludes all possibility of voluntary restriction, and the cause will probably be most fruitfully searched for in the realm of the pathological. So far, we have no experimental data to help us determine the fundamental etiology of this condition and we

must be content at this time to present our observations and advance a discussion of the cause from the basis of clinical reasoning. From the evidence thus far accumulated, interference of the motor nerve impulses to the affected hemidiaphragm is the most tenable etiological theory of this phenomenon which takes place in the short interval between the day previous to operation and the day after.

Anatomical muscular weakness has been suggested. Anatomical defects are more common on the left. The "high diaphragm" of this series is predominantly on the right side. Furthermore, it is hard to believe that 43 per cent of individuals have such a degree of one-sided muscular weakness, which is symptomless and not evident by X-ray examination before operation, that it would permit upward displacement of a hemidiaphragm to the extent seen in our series. Autopsies show no gross organic evidence of such a high percentage of malformation.

Engorgement of the liver would cause bilateral diaphragmatic rise because of its mobility. It moves up and down readily with respiration by virtue of the contractions of the diaphragm, and, therefore, a properly functioning right dome would exert sufficient restraint to an enlarged liver to cause it to press down into the abdominal contents, and thus, increasing intra-abdominal pressure, exert equal upward force on both sides of the diaphragm.

The X-ray plates themselves, as has been stated, rule out lung pathology as a cause of this condition. Those cases which exhibited sufficient atelectasis to require diaphragmatic upward displacement to compensate for the absorbed air have been excluded from this series.

Further evidence favoring interference with the motor nerve supply as the most important underlying factor, is presented by the fact that a considerable number of the

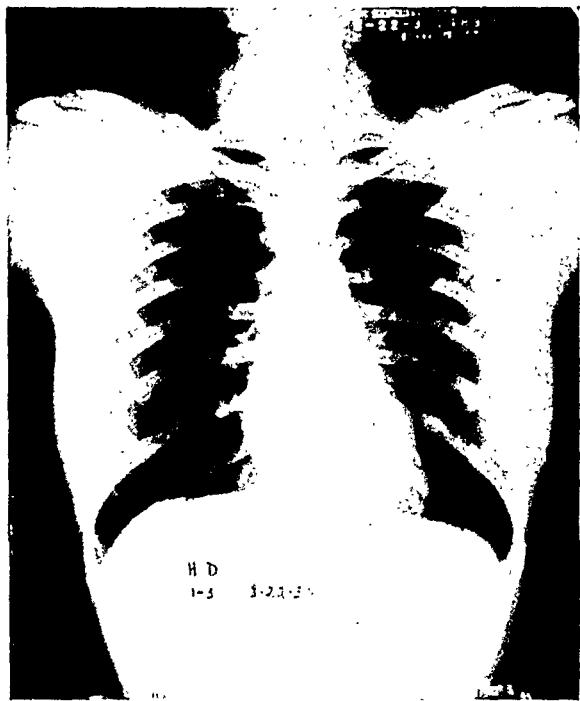


Fig. 9-A. Pre-operative X-ray examination. Cf. Figs. 9-B and 9-C.

high diaphragms show a higher arching with a sharper outline than the active opposite side and the same dome prior to operation (Figs. 5-A and 5-B). Radiographs of the diaphragm of normal persons show a sharper outline at expiration than inspiration because they are caught during the period of relaxation, a condition which is also made evident in plates following one-sided phrenicectomy. At inspiration a normal diaphragm tends to flatten, and, even though the patient does not breathe, there is often sufficient quivering of the contracted muscle to show a blurring of outline. This is demonstrated in longer exposures better than in those made in one-twentieth of a second. Comparison of the high and low halves in this series shows, in many cases, a blurring of the low dome and sharpness of the high one, presumably due to tonicity of the one and atonicity of the other. The high side undeniably approaches the shape, position, and sharpness of phrenicectomized hemidiaphragms, differing only in degree. This

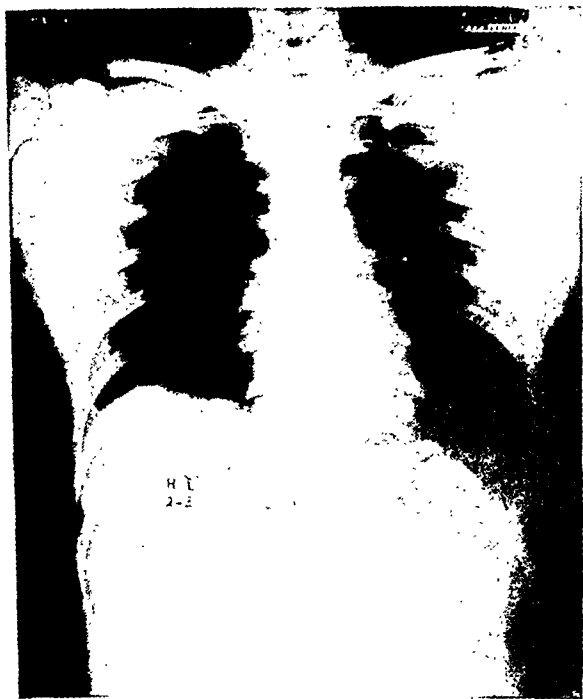


Fig. 9-B. Same case as shown in Figure 9-A, post-operative. Note the high right hemidiaphragm with clear lung above. Cf. Figs. 9-A and 9-C.

will be revealed by a study of the figures illustrating this article. Furthermore, in a few cases of high diaphragm, which we have radiated at inspiration and expiration, the unaffected dome travels farther than the affected one to a sufficiently greater extent than the average normal difference in the excursion of the two, to suggest the paradoxical action so characteristic of phrenicectomy.

The series of ten cases roentgenographed before and after gall-bladder operations of Sise and co-workers (12), previously mentioned, also exhibited inhibited excursion of the right hemidiaphragm in relation to the left half. Because neither half exhibits normal excursion following operation, the effect is not so dramatic as that following excision of a few centimeters of the phrenic nerve.

Observation of this series of cases reveals many instances of hypo-elevation of the ribs and lessening of the interspaces on the af-

fected side (Figs. 6-A and 6-B). They should show an increased excursion and widened interspaces on inspiration in the presence of a hypofunctioning diaphragm (10). This is because: (1) the diaphragm no longer peels from the chest wall in the lateral sulcus region; (2) less intrapleural negative pressure exists, and (3) there is increased inspiration effort to compensate for the hypofunction of the hemidiaphragm. The cases of hemithoracic narrowing and rib depression show no X-ray evidence to the effect that there has been any blockage of pulmonary access to external atmospheric pressure, which situation is immediately manifested on the X-ray plate by marked densities (9), in which condition atmospheric pressure on the external chest wall causes depression of the entire hemithorax by virtue of the fact that the same pressure is removed from the inside.

We can, therefore, logically proffer the question of accessory respiratory muscle enervation. The proposition that the diaphragmatic disturbance is the result of motor nerve impulse inhibition is enhanced by the possibility of a similar condition affecting accessory inspiratory muscles, and *vice versa*.

#### POSSIBLE CAUSES OF POST-OPERATIVE PARALYSIS OF ONE HEMIDIAPHRAGM

If temporary partial paralysis is the correct explanation of the observations described thus far, it is appropriate here to enumerate and briefly discuss some of the most tenable theories of etiology. None of the possible causes to be presented are irrefragable.

*Morphine.*—The administration of morphine does not appear to be responsible for the unilateral rise of the diaphragm. There is some evidence to suggest that it may increase the number of cases of bilateral high diaphragm and thus contribute to hypoventilation. A summary of the amount of mor-

TABLE II

RELATION OF AMOUNT OF MORPHINE ADMINISTERED BETWEEN OPERATION AND POST-OPERATIVE X-RAY EXAMINATION TO BILATERAL AND UNILATERAL HIGH DIAPHRAGM

Position of diaphragm	No. of cases	Average total amount of morphine given each patient
High unilateral position	33	59 mgm.
High bilateral position	49	60 mgm.
Diaphragms not affected	27	41 mgm.

TABLE III

OCCURRENCE OF HIGH HEMIDIAPHRAGM IN RELATION TO ANESTHETICS

Anesthetic	No. of cases	Case of high hemidiaphragm	
		No. of cases	Percentage
Ether	20	8	40%
Spinal, Rectal, and Local	9	3	33%
Gas (NO+O <sub>2</sub> and Ethylene)	66	21	32%

phine administered between the time of operation and the post-operative X-ray examination reveals that forty-nine cases in which, after operation, both diaphragms failed to travel through the distance of the pre-operative inspiratory excursion, averaged 60 milligrams. (Table II). The average total dosage of twenty-seven cases in which neither diaphragm was affected was 41 milligrams. The appraisal of the value of this relationship must be made with the realization that the operative cases to which the smaller doses were given had the less extensive operations, and the causes of bilateral rise are present in a less severe degree. The average dose given to thirty-three cases of asymmetrical high diaphragm was 59 milligrams. This is practically the same amount as that administered to the bilateral series.

There was no series of cases which had no morphine, to compare with the series

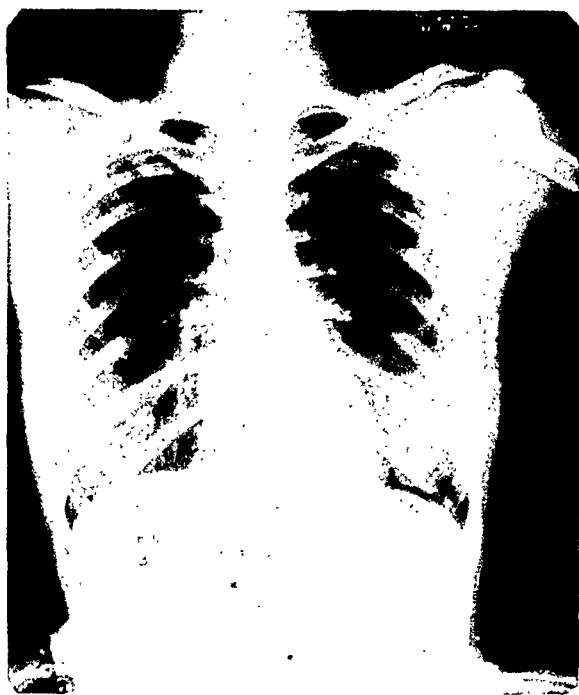


Fig. 9-C. Same case as shown in Figures 9-A and 9-B, three days after the latter. Diaphragm with domes again in normal relation.

which received morphine, and therefore we believe that the only conclusion which is suggested, in addition to the one mentioned, is that asymmetrical high diaphragm differs from bilateral high diaphragm due to other causes than the administration of morphine.

*Anesthetics.*—There was a total of sixty-six gas anesthetics and twenty-one (or about 33 per cent) in this series showed high asymmetrical diaphragms (Table III).

Twenty of the series were given ether. Of this number, eight (or about 40 per cent) had an asymmetrically high diaphragm.

The total number of rectal, local, and spinal anesthetics numbered nine. Three of this number (or 33 per cent) had a high hemidiaphragm.

The series thus far, therefore, indicates that the type of anesthesia has little to do with the incidence of this condition. The slightly higher percentage of ether cases hardly warrants serious consideration.



Fig. 10-A. Pre-operative chest roentgenogram of thyroidectomy case. Exposure insufficient to penetrate breast shadows and bases. Cf. Fig. 10-B.



Fig. 10-B. Same case as shown in Figure 10-A, post-operative. High hemidiaphragm. Lung above clear. (Apparent mediastinal shift probably due to rotation of patient.) A little perihilum atelectasis cannot be entirely excluded. The density at the right apex is due to removal of substernal goiter. There is not sufficient atelectasis in any event to require so great an ascent of the diaphragm.

*Type of Operation.*—Table I indicates that there were sixteen cases of high hemidiaphragm out of a total of thirty-four low abdominal operations, and eight cases out of thirteen high abdominal operations. This shows a ratio of 47 per cent to 61 per cent, a difference which can hardly be ignored. Abdominal cases as a whole show 54 per cent to be affected by asymmetrical high diaphragm. A high incision in the abdomen apparently is more effective in producing this condition than the low incision.

Ten kidney operations, with flank incisions, showed six cases (or 60 per cent), closely approximating the high abdominal percentage. Four herniotomies showed three high diaphragms—a percentage of 75. The small number of these cases, however, precludes a definite opinion of the correct percentage. All three cases showed high *right* diaphragms. One had a midline incision (umbilical hernia). and

the other two left-sided incisions (left inguinal). These cases, combined with two high left diaphragms (one of which is shown in Figures 7-A, 7-B, and 7-C), which occurred with right-sided incisions, and with numerous cases of midline incisions followed by right high diaphragm, strongly indicate that the position of the incision in relation to the right or left side in abdominal cases does not decide which half of the diaphragm will be affected.

All other operations, a list of which is shown in Table I, numbered thirty-four. Of this group, only six (17 per cent) had asymmetrically high diaphragm, indicating a much lower percentage than did abdominal, kidney, and herniotomy cases.

It is logical to conclude, therefore, that the type of operation has more effect than

either the type of anesthetic or the administration of morphine.

#### ENUMERATION OF OTHER POSSIBLE CAUSES

Thoughtful consideration of the possible causes of the phenomenon which is the subject of this paper points to the probability of a multiple etiology. When satisfactory explanation of intraperitoneal cases is evolved, the fact that the condition occurs in such cases as curettement and thyroidec-tomies confronts us. That the right diaphragm is affected so much more than the left, should be used as a fact to help determine the cause. Except for one suggestion, mentioned later, no likely single etiological factor for all cases has occurred to us, so we will be content to state different possible causes for different types of operation.

It has long been known that peritoneal cavity lymphatic drainage is much more active to the right hemidiaphragm than to the left (13), due to liver friction and undoubtedly to other causes. That the right subdiaphragmatic area is more easily reached from the intraperitoneal cavity is further suggested by an observation in our series; in all cases which showed residual air admitted through the incision, it was found under the right hemidiaphragm (Fig. 5-B). From the diaphragm the lymphatics drain upward by diagonal trunks to the sternum and anterior mediastinum along the *phrenic nerve* to the hilum region of the lung,—a few vessels go directly to the thoracic duct.

The abdominal cases of high hemidiaphragm, then, could be thought of as being caused by the effect of toxic traumatized protein carried to the right hemidiaphragm, and occasionally the left, where it is held, by disturbed absorption, in apposition to the phrenic nerve terminations, interfering with their conduction. Then after the toxins are finally absorbed they may produce an inflammatory reaction along the course of the

phrenic nerve and perhaps even in the mediastinal lymph-node area. A "vicious circle" situation presents itself on the under surface of the diaphragm. We know that phrenicectomy retards absorption; thus after the first interference of conduction through the phrenic terminations which are spread out on the under side of the muscle, absorption is retarded and more time given for still further inhibitory effect on the nerve terminations.

Reflex effect on the phrenic nerve from impulses carried through the vagus warrants mention here.

If interference of function of the gastrointestinal tract, not only by direct trauma but reflexly by the effect of the anesthetic and shock, causes a toxic material in the abdominal cavity to be liberated into the lymphatics and thence to the diaphragm, a possible cause of all cases is suggested. The smaller the operation and the more distant from the abdomen, the less the gastrointestinal effect. The evidence of the cases listed in Table I strengthens this opinion.

We know that inflammation of the pleura above the diaphragm is often given as a cause for palsy of this organ and doubtless is the reason for its high arching in certain types of supradiaphragmatic disease. It is difficult, however, to conceive of a reason for a pleural inflammatory process in many of the types of surgical cases which have been followed by high hemidiaphragm, and it could hardly become effective in the short time between operation and post-operative X-ray examination.

General shock, with resulting phrenic nerve inhibition of cerebral origin, or the same result from cortical toxemia or lowered blood chlorides from intestinal stasis, must be included in our list of possible causes. This, however, suggests the question as to why the result should be unilateral. Some of our cases, of course, may have bilateral inhibition, which, because of the normal ex-

cess of excursion of the right hemidiaphragm, is manifested more on the right than on the left side, and therefore is not recognized as occurring on both sides.

Another consideration worthy of inclusion in this list is possible pressure on the phrenic nerve along its intrathoracic course. We know that long-continued pressure, such as that caused by effusions, empyema, tumors, and inflammatory processes of the mediastinum, may bring about phrenic nerve paralysis (14). Engorgement of the superior vena cava may also increase the mediastinal pressure on the phrenic nerve. The lessened abdominal pumping, because of the bilateral failure of the diaphragm to function fully after operation, upon the abdominal inferior vena cava might lend to this condition.

It is conceivable that cardiac dilatation could cause stretching of or pressure upon the pericardial portion of that nerve.

#### RELATIONSHIP TO POST-OPERATIVE CHEST COMPLICATIONS

Whether high hemidiaphragm is the result of paralysis or not, and regardless of the cause of the problematical paralysis, the fact that a certain percentage of cases presents a high clear-cut arch of one dome only, without demonstrable collateral lung disease, has a certain significance in the interpretation of bedside post-operative X-ray examinations of the chest.

Knowledge that this condition exists warns one against interpreting a high dome plus hypoventilation as sufficient evidence upon which to base an opinion of massive atelectasis. It is probable that many of us who make post-operative X-ray studies of the chest have more than once rendered an opinion of atelectasis in the presence of this combination of X-ray signs, and wondered at the time how atelectasis of sufficient degree to cause these marked signs could exist

without exhibiting more density, and why the mediastinum did not do its share of the compensation. Perhaps reports in the literature (2) which refer to restriction of a hemidiaphragm as an early sign of atelectasis are based on this condition. It is probably more nearly correct to look upon it as a contributing causal factor rather than a resultant sign.

A paralytic hemidiaphragm may be the explanation of a demonstration in massive atelectasis cases which has been puzzling some of us for a long time. Thus, one of two cases of massive atelectasis of apparently equal areas of lung involvement will show high ascent of the collateral diaphragm and a small amount of mediastinal shifting, while the other case will show short diaphragmatic ascent and a wide mediastinal shift toward the affected lung. Is it not possible that inhibition of the diaphragm in one case and good tonicity in the other might account for this phenomenon? The repeated occurrence of this variation in the replacement action of the diaphragm and mediastinum in previously healthy chests in which there are no adhesions of mediastinum or pleura, strengthens the evidence that inhibition is a cause of the unilateral high position of the diaphragm as a condition preceding atelectasis. High, poorly functioning hemidiaphragm is a likely contributing cause to post-operative atelectasis, for it cannot be denied that a lung deprived of its more important muscle of respiration will have more difficulty in maintaining freely open passage away from the lung field to the outside atmosphere.

#### SUMMARY

1. Forty-three per cent of ninety-four surgical cases subjected to pre- and post-operative chest X-ray examinations have shown a unilateral high position of one hemidiaphragm. The immediate cause of

this observation is undetermined, but may be due to paralysis.

2. Fifty-seven per cent exhibited bilateral high position of the domes. The causes are more obvious and apparently do not include paralysis.

3. Both phenomena, but especially the unilateral high diaphragm, deserve attention in the study of the diagnosis and treatment of post-operative chest complications and in interpretation of post-operative X-ray examinations. Cases exhibiting both conditions at once cause the heart to assume a horizontal position suggesting displacement to one side or the other, and this, combined with a high position of one dome of the diaphragm, may give an erroneous impression that atelectasis is present.

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cess of excursion of the right hemidiaphragm, is manifested more on the right than on the left side, and therefore is not recognized as occurring on both sides.

Another consideration worthy of inclusion in this list is possible pressure on the phrenic nerve along its intrathoracic course. We know that long-continued pressure, such as that caused by effusions, empyema, tumors, and inflammatory processes of the mediastinum, may bring about phrenic nerve paralysis (14). Engorgement of the superior vena cava may also increase the mediastinal pressure on the phrenic nerve. The lessened abdominal pumping, because of the bilateral failure of the diaphragm to function fully after operation, upon the abdominal inferior vena cava might lend to this condition.

It is conceivable that cardiac dilatation could cause stretching of or pressure upon the pericardial portion of that nerve.

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#### SUMMARY

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screen. But so far as we have been able to discover there has been no attempt to use  $\gamma$ -rays for the inspection of opaque bodies except that reported from Russia.<sup>3</sup> According to the meager information available it

characteristics of  $\gamma$ -rays. Since the source of  $\gamma$ -rays used was radium emanation, the most suitable source, these notes will be restricted to  $\gamma$ -rays as obtained from radium emanation.

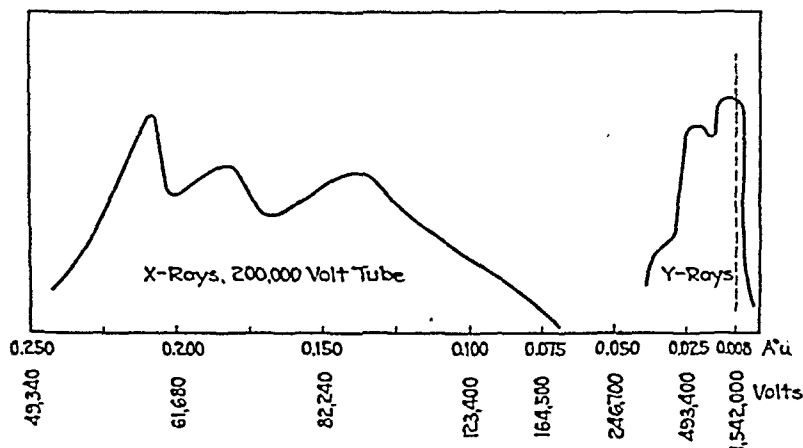


Fig. 2. Curves showing intensities at various wave lengths for X-rays (Terrill and Pine) and for  $\gamma$ -rays (Skobelzyn). The dotted line represents the mean value for  $\gamma$ -rays. (Given by Ellis and Wooster.)

was found possible to locate flaws in steel castings, detecting the emergent beam by an electroscope or a galvanometer and recording the intensity of the beam automatically. No details of this work have ever been made public, so far as the present authors are aware.

It may be said, therefore, that but little has been done on the use of  $\gamma$ -rays for radiography. The present investigation is an attempt, in a preliminary way, to evaluate the use of  $\gamma$ -rays for the detection and location of defects in metallurgical materials.<sup>4</sup>

#### THE PHYSICS OF $\gamma$ -RAYS

In order that the ensuing account may be made clear it is thought advisable to comment briefly upon certain of the physical

Possibly the most noteworthy fact about the radio-active elements is that they transform or decompose to chemically and physically different elements. These transformations are accompanied by radiation, of which there are three types, the  $\alpha$ -rays, which are known to be helium atoms with a double positive charge,  $\beta$ -rays, which are electrons, and  $\gamma$ -rays, which are light waves of very short wave length. The first product in the decomposition of radium is radium emanation, or radon. It is a chemically inert gas,

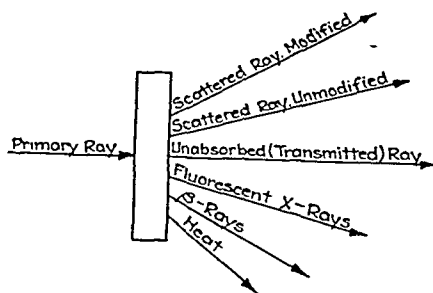


Fig. 3. Changes suffered by radiation in penetrating matter.

<sup>3</sup>As published by Science News Service, No. 361E, Sheet 1, Feb. 24, 1928. It has been impossible to obtain by correspondence information additional to that appearing in the Science News Service report.

<sup>4</sup>The experiments described in the following were performed during the Summer of 1929.

over a hundred times heavier than hydrogen. This gas, radon, in turn decomposes and forms successively Radium A, Radium B,

this, it may be seen that a given quantity of radium produces a constant quantity of radium emanation each second, which, in

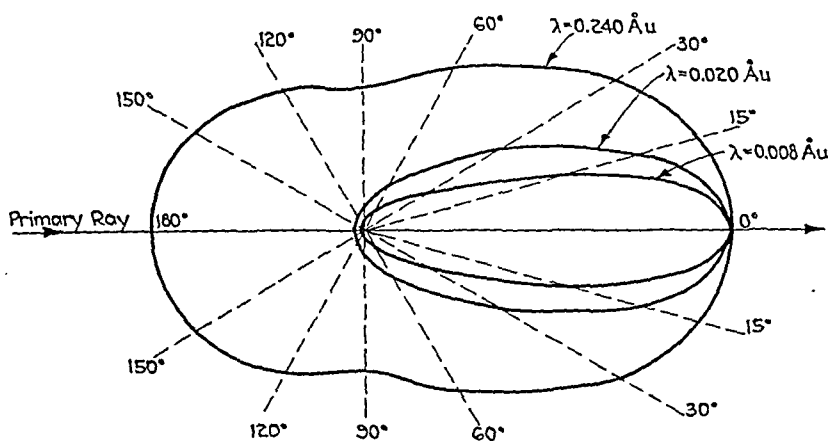


Fig. 4. Distribution of intensity of modified rays scattered at various angles, with primary rays of wave length 0.240 Å.U. (X-rays), 0.020, and 0.008 Å.U. (γ-rays).

Radium C, Radium D, etc., with the final product lead.

Each of these radio-active elements is characterized by a certain rate of decomposition. If the amount present be evaluated (in the usual way) by the strength of the radiation emitted, the rate of decay may be given as

$$\frac{I}{I_0} = e^{-\lambda t}$$

where  $I$  is the intensity measured after time  $t$ ,  $I_0$  the original intensity, and  $\lambda$  is the fraction of atoms present which transforms in time  $t$ . This is a general law for all radio-active substances. Accordingly, the strength of all radio-active substances decreases logarithmically with time (Fig. 1). Since it is impossible to speak of the life of the emanation (for it is infinite), it is customary to speak of the half-life period, that is, the period in which the radio-active strength decreases to half its original value.

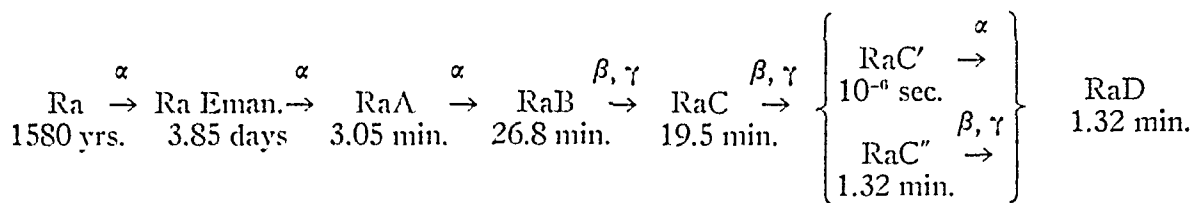
The half-life of radium is about 1600 years. It may, therefore, over a short period be considered as unchanging. Granted

turn, decomposes to Radium A, and so on. With a constant rate of production of radium emanation the amount of radium emanation will build up until the rate of decay of the emanation exactly balances the rate of its formation. At this point the radium and its emanation are said to be in equilibrium.

The transformation of radium to radium emanation is accompanied only by an emission of  $\alpha$ -rays. So far as  $\gamma$ -rays are concerned, the radio-active properties of radium in equilibrium with its products are, therefore, possessed completely by the radium emanation, and for practical purposes it is better to use the emanation.

In medical practice radium emanation is pumped from the parent radium salt (usually in solution) and condensed from the gases with which it is mixed by liquid air. Each gram of radium in the equilibrium state furnishes 0.6 cubic millimeter of gas. This condensed gas is pumped into small glass capsules ordinarily held in small brass containers. The chief source of  $\gamma$ -rays seems to be Radium C, into which radium emana-

tion decomposes. This series of transformations, with the radiations which accompany them and with the half-life periods, is indicated by the following:<sup>5</sup>



As freshly pumped off the emanation reaches its maximum radiating intensity within a few hours, the time necessary for the production of the maximum amount of RaC. Thereafter the strength decreases logarithmically, according to Figure 1, the half-life period being 3.9 days.

The strength of the emanation is measured in millicuries, a millicurie being the strength of 1 milligram of radium in equilibrium with its products as measured by an electroscope receiving the  $\gamma$ -rays only. In medical practice it is customary to pump off the emanation each day. With this procedure, one gram of radium will furnish 160 millicuries of the emanation daily, of which

about 150 millicuries is recovered by a skilled operator. Accumulating this emanation day by day one may build up a permanent stock of emanation, with a total

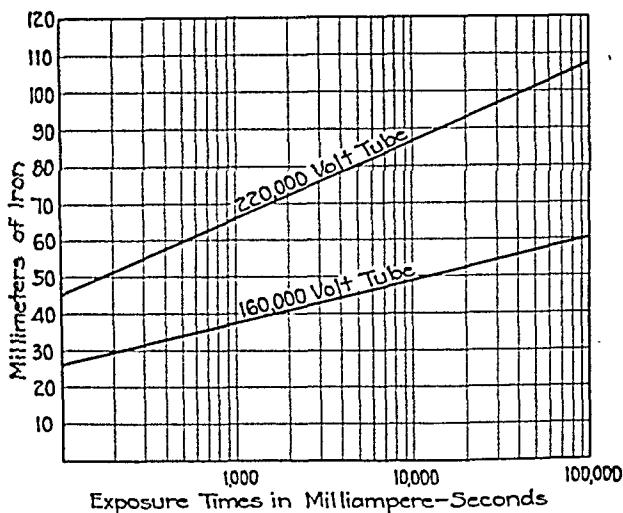


Fig. 5. Exposure curves for X-rays; for a distance of 16 inches from source and with the use of two intensifying screens.

<sup>5</sup>See, for example, A. Sommerfeld: *Atomic Structure and Spectral Lines*, Methuen & Co., Ltd., London, 1923, p. 47.

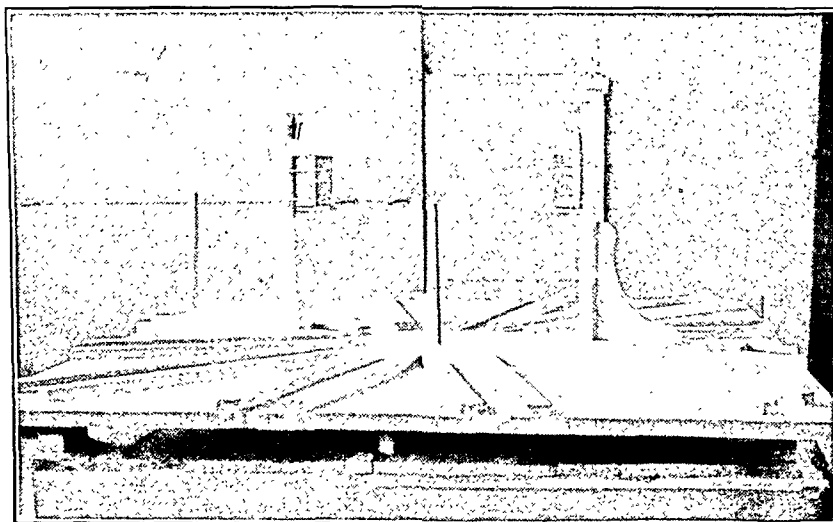


Fig. 6. Table used in  $\gamma$ -ray radiography. Funnel holding radium emanation shown in center.

strength between 800 and 900 millicuries available for radiographic purposes.

*Wave Length of  $\gamma$ -rays.*—Approxima-

The relative intensities found by Skobelzyn for the various wave lengths in the  $\gamma$ -ray spectrum are shown in Figure 2.<sup>8</sup>

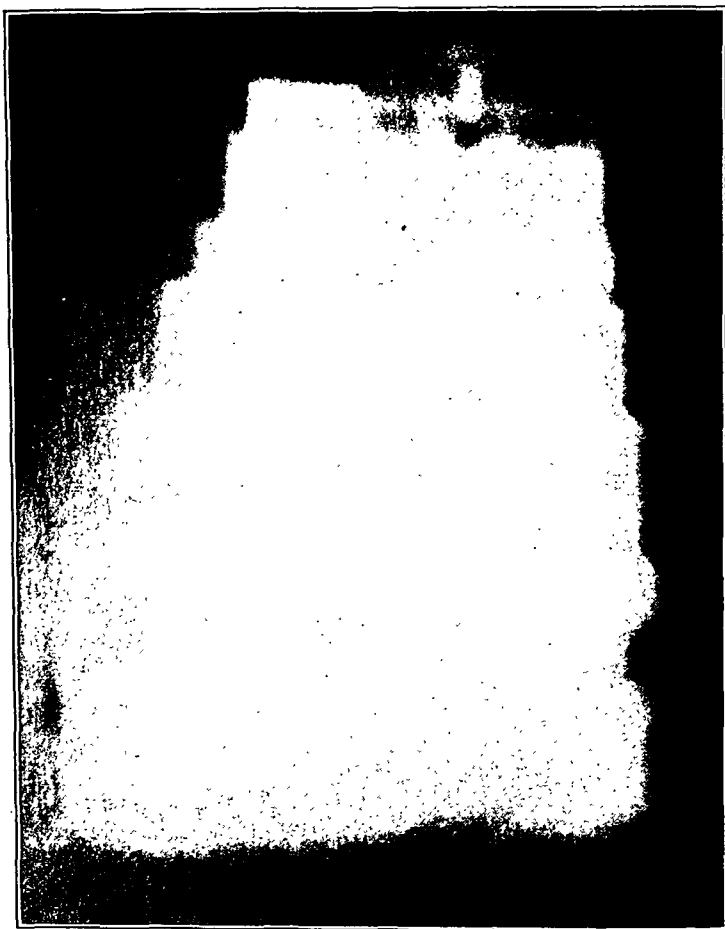


Fig. 7. An echelon of steel plates, as illustrated in Figure 8 (Film No. 1). Distance, source to film, 6 in.; intensifying screen, none; time of exposure, 25 min.; mean strength of emanation, 179 millicuries in one bulb. *Results:* Considerable detail on original negative lost in this illustration. Original exposure just sufficient to bring out all details, though enhancing screens would have decreased the exposure time. The spreading on the film was caused, of course, by the closeness of the object to the source.

tions have been made indicating<sup>6</sup> that the  $\gamma$ -ray spectrum lies somewhere in the range 4.100 to 0.005 Å.U. The distribution of intensity in the  $\gamma$ -ray spectrum has recently been studied by a number of workers.<sup>7</sup>

<sup>6</sup>Meyer and Schweidler: Radioaktivität, Teubener, Berlin, 1927, p. 148.

<sup>7</sup>D. Skobelzyn, Ztschr. f. Phys., 1927, XLIII, 368; K. W. F. Kohlrausch, Phys. Ztschr., 1927, XXVIII, 2; J. Thibaud, Ann. de Phys., 1925, V, 119; C. Ellis and W. Wooster, Proc. Camb. Phil. Soc., 1925, XXII, 853; idem, 1925-27, XXIII, 717-729.

<sup>8</sup>It seems likely that the  $\gamma$ -ray spectrum, originating from an atomic disintegration, is not a "white" or continuous spectrum, but a spectrum of discrete lines. As the ray emerges from the atom, however, it doubtless suffers a modification in wave length owing to interaction with the radioactive substance itself and with any filter in its path, converting the separate rays through Compton scattering into a continuous spectrum. Skobelzyn determined the relative intensities of the different wave lengths by the number of recoil electrons of given velocity (corresponding to a given wave length of  $\gamma$ -ray) in a Wilson cloud chamber. His curve is "ironed out" in Figure 2 to give a smoother curve than he observed, and Figure 2, therefore, makes the intensity distribution appear more equable than it probably is. There is still some question as to where the limits of the  $\gamma$ -ray spectrum lie. There is evidence of rays at wave lengths greater than 0.040 Å.U., and some suggestion of rays around 0.002 Å.U. The limits of the  $\gamma$ -ray spectrum are, therefore, not defined in Figure 2. In addition, Skobelzyn's determina-

The measurements made by Ellis and Wooster suggest a mean wave length for the  $\gamma$ -ray spectrum of 0.008 Å.U., corresponding to a voltage of 1,500,000 volts as indicated in Figure 2, somewhat shorter than the approximate mean wave length to be derived from Skobelzyn's curve. On Figure 2 is also represented the relative intensities found by Terrill and Pine<sup>9</sup> for the various wave lengths in the X-ray spectrum as obtained from a 200,000-volt X-ray tube with a tungsten target after filtering through 1 mm. of copper. It is to be noted that the  $\gamma$ -ray curve in Figure 2 applies to

tion of distribution of intensities rests upon only 160 observed recoil electron paths, a number insufficient to define the intensity distribution curve with high accuracy. The curve given in Figure 2 may, however, be taken as approximately correct. The data from which Figure 2 was plotted refer to  $\gamma$ -rays filtered through 3 mm. of lead.

<sup>9</sup>H. M. Terrill and Mary Pine: Jour. Cancer Research, 1924, VIII, 71.

$\gamma$ -rays after filtering through 3 mm. of lead, whereas the X-ray curve was taken with 1 mm. copper filter. This difference in filters

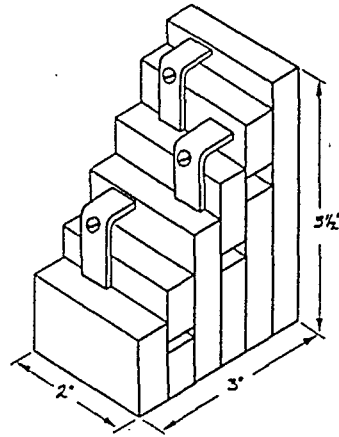


Fig. 8. Diagram of built-up specimen radiographed in Figure 7.

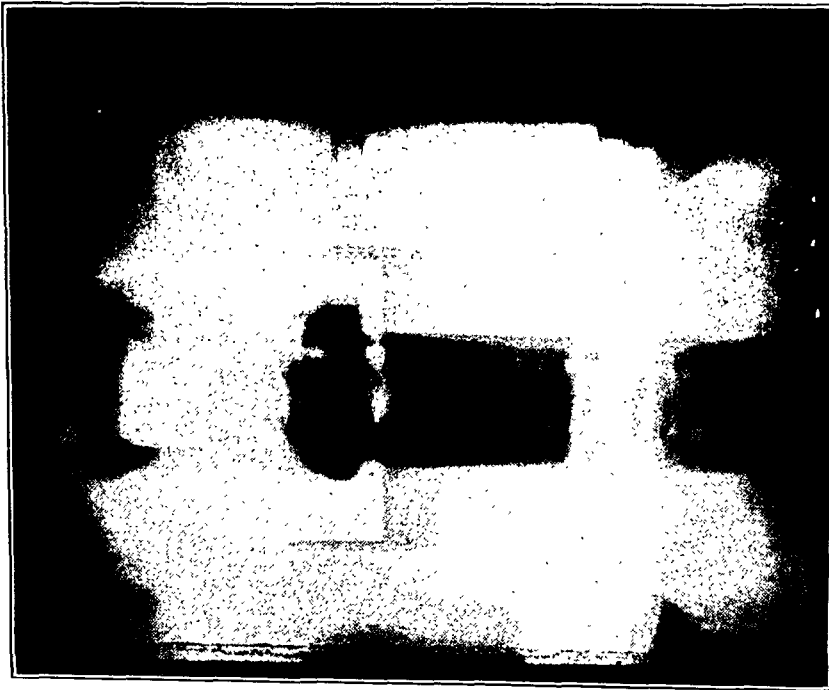


Fig. 9. A tool rest from a lathe. Overall length of section photographed 8 1/2 in.; height, 6 1/2 in. (Film No. 2). Distance, source to film, 26 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 181 millicuries in one bulb. *Results:* Film badly over-exposed. With intensifying screens only a small fraction of the exposure time noted would have been necessary. A high degree of detail was brought out on the original film.

exerts some distorting effect upon the true distribution curves, but for the present purpose the curves given in Figure 2 may be taken as a nearly true index of the distribution of wave lengths in the two spectra.

X-ray bulb or a tube of radium emanation. In Figure 2 the two curves are drawn simply to give approximately equal heights. It is, of course, the much shorter wave length of the  $\gamma$ -ray as indicated in Figure 2 which

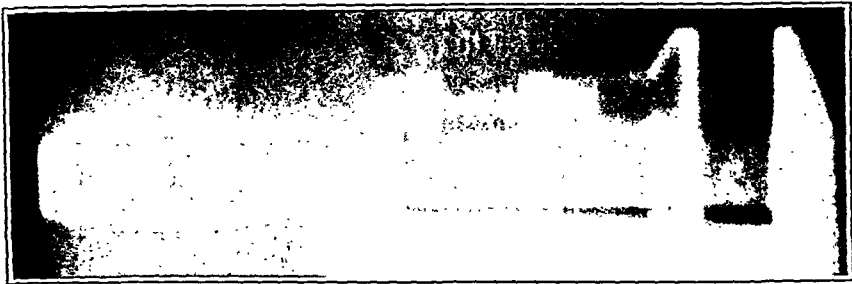


Fig. 10. Wrench,  $8\frac{1}{2}$  in. long (Film No. 3). Distance, source to film,  $66\frac{1}{2}$  in.; intensifying screen, none; time of exposure,  $10\frac{1}{2}$  hrs.; mean strength of emanation, 2,181 millicuries in six bulbs. *Results:* All details shown very clearly. Film somewhat over-exposed. Distance from source very great. With a shorter distance and by the use of intensifying screens, a shorter time and a weaker source would have sufficed. Note increase in sharpness of all details in Films No. 1 to No. 3, with increase in distance from source to film, as to be expected. The lack of halo around the edge of the specimen indicates that the usual precautions taken in X-ray radiography to prevent halo are unnecessary when radiographing thin specimens by  $\gamma$ -rays.



Fig. 11. Faulty weld,  $2\frac{1}{2}$ -in. steel plates, lap-welded (Film No. 4). Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 217 millicuries in one bulb. *Results:* Lack of bond clearly shown (indicated by arrows). This reproduction is not nearly so good as the original film. Exposure excessive. Time of exposure could have been much less, especially by use of Patterson screens.

The areas under the intensity curves in Figure 2 are entirely dependent upon the intensity of the source, whether it be an X-ray bulb or a tube of radium emanation. In Figure 2 the two curves are drawn simply to give approximately equal heights. It is, of course, the much shorter wave length of the  $\gamma$ -ray as indicated in Figure 2 which accounts for the much lower absorption of the  $\gamma$ -rays in radiography.

*Absorption and Scattering.*—The  $\gamma$ -ray

beam issuing from a bulb of radium emanation has approximately the distribution of wave lengths indicated in Figure 2 (after, as noted, passing through 3 mm. of lead, which absorbs the softer rays preferential-

through simple absorption (converted into heat) and through scattering. This emergent intensity may be represented by an equation

$$I = I_0 e^{-\mu x}$$



Fig. 12. Faulty weld, butt-welded (Film No. 5). Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 179 millicuries in one bulb. Results: Imperfections clearly shown.

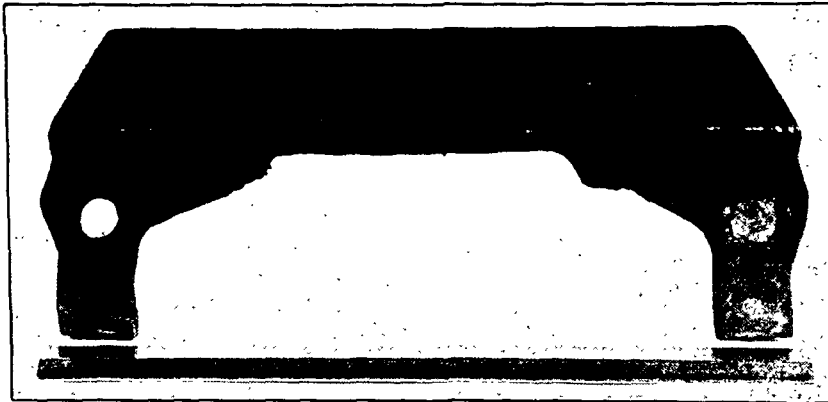


Fig. 13. Photograph of steel casting of which radiographs are shown in Figures 14 and 15.

ly). As this ray passes through a metal object it suffers a number of changes. The emergent ray is complex, as indicated in Figure 3.

The emergent  $\gamma$ -ray beam is weaker than the direct beam because of loss of intensity

where  $I_0$  is the initial intensity (assumed to be a simple wave length),  $x$  the thickness of the absorbing medium, and  $\mu$  the total absorption coefficient.

The total absorption coefficient  $\mu$  is actually affected by two agencies, namely,



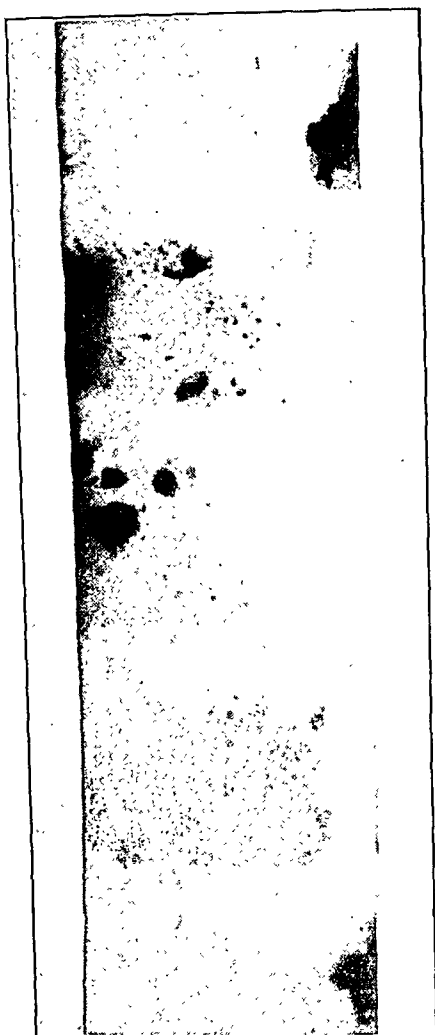


Fig. 14



Fig. 15

Fig. 14 (left). Steel casting with sand inclusions, shown in Figure 13. Thickness of web between ribs,  $\frac{1}{4}$  in. of rib at base, 1 in. (Film No. 6). This X-ray radiograph shows clearly the presence of sand inclusions. The method of photographic reproduction has increased the contrast considerably in Films No. 6 and No. 7. The figure "2" has no significance.

Fig. 15 (right). Film No. 7. Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 217 millicuries in one bulb. *Results:* Film darker than necessary. Fairly good reproduction of original film except detail in ribs lost. With Patterson screens the exposure time could have been very considerably decreased.

A comparison between Figures 14 and 15 is important in comparing the  $\gamma$ -ray and the X-ray methods for radiography. Every detail which could be discovered upon the X-ray photograph (Fig. 14) could also be found upon the  $\gamma$ -ray photograph (Fig. 15). The contrast upon the film between a defect and the background is greater upon the X-ray film. Because of the lower absorption coefficient for  $\gamma$ -rays, however, the whole of the casting is satisfactorily exposed upon the  $\gamma$ -ray photograph, whereas the ribs are badly under-exposed upon the X-ray film. It is possible that a better X-ray photograph could be obtained, but it is inescapable that it should be easier to radiograph an irregular section with  $\gamma$ -rays than it is with X-rays. Precautions were taken to eliminate scattering at the edges of the specimen in the X-ray radiograph of this piece (Film No. 6), but not in this  $\gamma$ -ray radiograph. The complete lack of halo at the edges of the casting indicates that such precautions are unnecessary when  $\gamma$ -rays are used on rather thin specimens.

true absorption and scattering. Neither X-rays nor  $\gamma$ -rays from a bulb of radium emanation are homogeneous in wave length (Fig. 2). Accordingly the first absorbing layers remove a large fraction of the less

It has been stated that the total absorption coefficient represents the sum of a true absorption coefficient and a scattering coefficient. The scattered ray is of considerable importance to radiography, since it com-

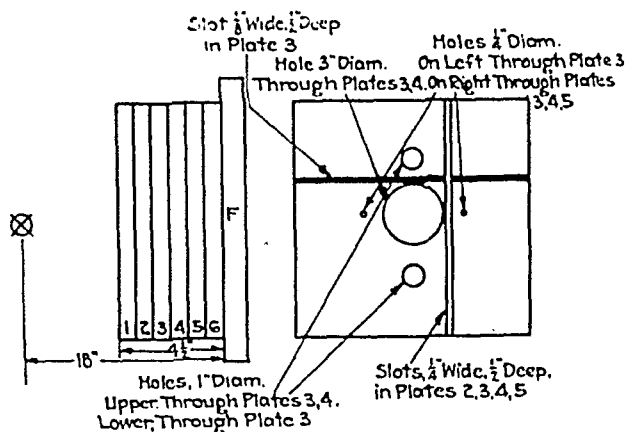


Fig. 16. Diagram showing method of preparing specimen radiographed in Figure 17.

penetrating rays, so that only the more penetrating or "hard" rays reach the final layers. For such non-homogeneous beams the effective value of  $\mu$  is much greater for the rays which enter the absorbing object than for those which leave it. According to Kohlrausch,<sup>10</sup> the total absorption coefficient for  $\gamma$ -rays may be represented by two absorption coefficients,  $\mu_1$ , and  $\mu_2$ , where

$$I = I_0 \left( e^{-\mu_1 x} + 0.75 e^{-\mu_2 x} \right),$$

for iron  $\mu_1 = 0.356$  and  $\mu_2 = 0.632$  cm.<sup>-1</sup>, with an average value in the neighborhood of 0.5 cm.<sup>-1</sup>.

Taking 0.15 Å.U. as the effective wave length of X-rays from a 200,000-volt tube (Fig. 2), the corresponding coefficient for iron is 4.5 cm.<sup>-1</sup>. These coefficients thus indicate the greater penetrability of the  $\gamma$ -rays.

only fogs the registering film. To combat the scattering, various screening devices have been introduced, such as simple lead shields and the more complicated Potter-Bucky diaphragm.<sup>11</sup>

The scattering of  $\gamma$ -rays differs from that of X-rays owing to the shorter wave length. The difference is in three categories: (a) the fraction of the beam scattered (the magnitude of the scattering coefficient), (b) the angular distribution of the scattered ray, and (c) the modification of the wave length upon scattering<sup>12</sup> (Compton effect).

(a) It is difficult to make any definite statement concerning the ratios of the true absorption and scattering coefficients for X-rays and  $\gamma$ -rays, except that both these coefficients are smaller for  $\gamma$ -rays than

<sup>11</sup>See, among many publications, that of the Eastman Kodak Company, entitled "X-rays in Industry," 1929.

<sup>12</sup>Fluorescent radiation in both the X-ray and  $\gamma$ -ray technic is absorbed before reaching the film and need not be considered here. The ejected photo-electrons suffer a similar fate.

<sup>10</sup>Meyer and Schweidler: Radioaktivität, Teubener, Berlin, 1927, p. 644.

X-rays. There is a lack of data from experiments duplicating radiographic conditions.

(b) The angular distribution of intensity is of peculiar interest in radiography. Both

angular distribution for the former gives approximately the distribution of the total scattering. Figure 4 gives a series of such curves,<sup>13</sup> and indicates that the distribution of the scattered ray should be less detrimental

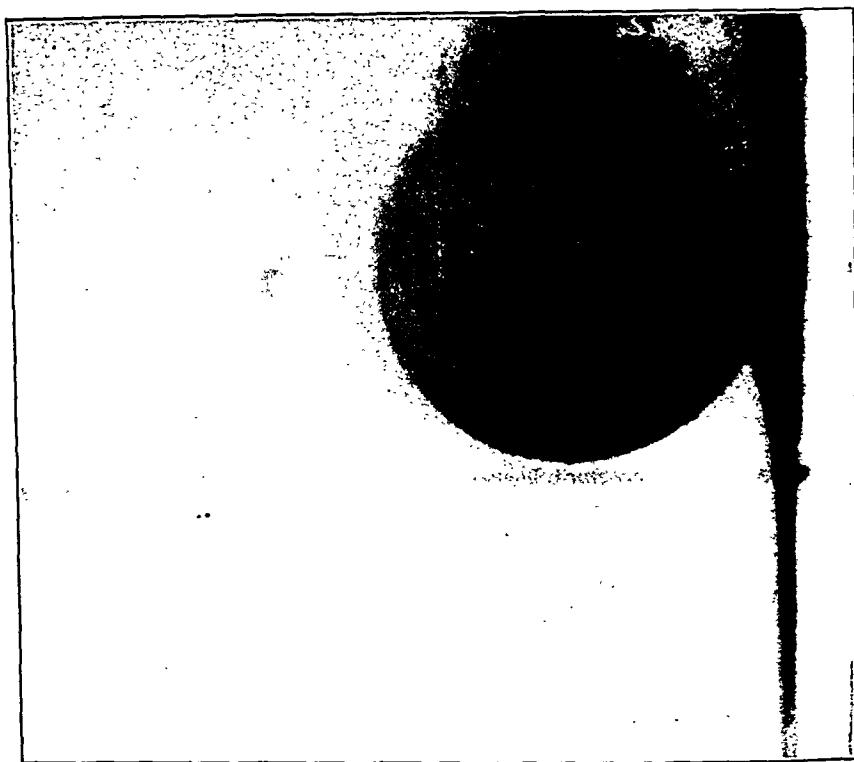


Fig. 17. A series of steel plates, in certain of which were cut holes of several diameters, and slots. Details of arrangement are given in Figure 16 (Film No. 8). Distance, source to film, 18 in.; intensifying screen, film between two Patterson screens; time of exposure, 12 hrs.; mean strength of emanation, 198 millicuries in one bulb. *Results:* Film much darker than necessary. Half the stated exposure time would easily have been sufficient. Contrast on this illustration somewhat greater than on original film. Fogging shown in upper right-hand corner is only very light on the original film. Film covered only part of detailed plate in Figure 16, as may be seen by a comparison of Figures 16 and 17. Smallest hole in left is of particular interest. It appears very strongly here, though it is only  $\frac{1}{4}$  in. in diameter and  $\frac{3}{4}$  in. deep, showing that the  $\gamma$ -ray method in this case brought out strongly a defect  $\frac{1}{4}$  in. in diameter and 17 per cent of the total thickness deep. A similar sensitivity is shown by the lower 1-inch hole. The sensitivity of the method is shown also by the following film.

the modified and the unmodified ray are distributed more in the direction of the primary beam in the case of the shorter wave lengths than in the case of the longer. Under radiographic conditions the modified rays predominate over the unmodified at practically all scattering angles, so that a curve of

tal to the production of good  $\gamma$ -ray radiographs than to good X-ray radiographs.

(c) The scattered  $\gamma$ -ray beam suffers a profound modification through the operation of the Compton effect, and in this

<sup>13</sup>K. W. F. Kohlrausch: *Handbuch der Experimentalphysik*, Vol. XV, p. 132.

respect differs greatly from X-rays. The Compton scattering is an increase in the wave length of the primary beam, the amount of increase dependent upon the angle the scattered beam forms with the

the angular distribution of the scattered  $\gamma$ -ray beam, since the beam scattered at the greater angles will be more rapidly absorbed by the specimen.

These various considerations indicate that

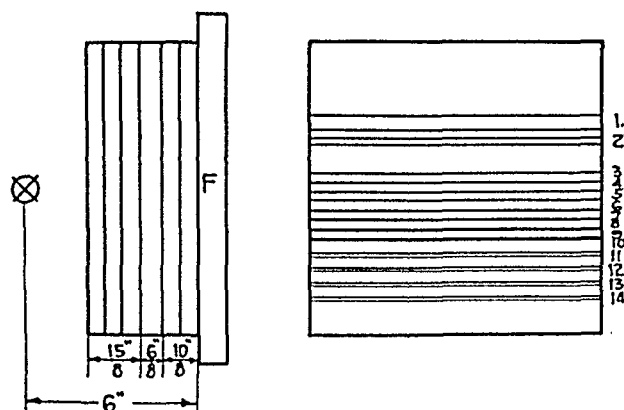


Fig. 18. Diagram showing method of preparing specimen radiographed in Figure 19. Dimensions of slots were as follows:

No.	Width in mm.	Depth in mm.
1	13	13
2	6	13
3	1	2
4	1	3
5	1	6
6	1	12
7	2	2
8	2	3.5
9	2	6.5
10	2	12

primary beam but independent of the original wave length. A beam scattered at an angle 90 degrees to the primary beam suffers an increase in wave length of 0.024 Ångström unit. Such an increase will make only relatively little difference in the scattered X-ray wave lengths (since the effective wave length of the primary beam from a 200,000-volt tube is about 0.15 Å.U.), but will make a great difference in the scattered  $\gamma$ -ray wave lengths (which are principally between 0.030 and 0.004 Å.U.), dependent upon the angle of scattering.

The scattered  $\gamma$ -ray beam will, therefore, have a much greater wave length at large angles and a proportionately much greater absorption coefficient. This will, in effect, so far as radiography is concerned, narrow

scattering from  $\gamma$ -rays should not be a greatly harmful influence in  $\gamma$ -ray radiography, and the degree of success attained in the experiments soon to be described bears testimony to the correctness of this viewpoint.

*Photographic Exposure Characteristics.*—A great deal has been written about photographic exposure characteristics for radiography by the use of X-rays. The information desired is simply the shortest exposure time for a given thickness of metal necessary to reveal upon the developed photographic film the density differences—defects—occurring in the object inspected.

There is a fairly wide latitude in the choice of exposure times for different thicknesses, dependent upon the observer's taste

in film density and upon what deviations from the simplest technic are used, such as

lute blackening is determined by photometric measurements in which the intensity of the

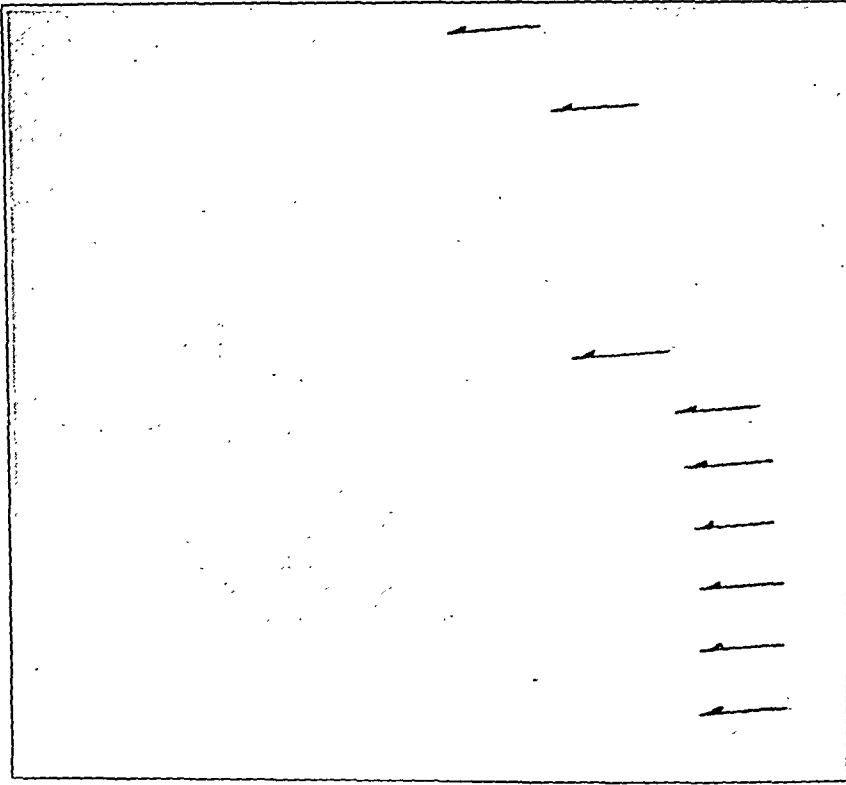


Fig. 19. A series of steel plates, total thickness  $3\frac{7}{8}$  in., in one of which (marked "6/8" in Figure 18) a number of slots of varying depth and width were cut. Details are given in Figure 18. The slotted side of the plate was turned towards the film (Film No. 9). Distance, source to film, 6 in.; intensifying screen, none; time of exposure, 4 hrs.; mean strength of emanation, 179 millicuries in one bulb. *Results:* This radiograph was taken to test the sensitivity of the  $\gamma$ -ray method for small defects. It must, of course, be borne in mind that the slots illustrated in Figure 18 are well defined geometrically, which is favorable to the test. The original film was nearly of correct exposure, though the use of Patterson screens would have decreased the exposure time. Owing to the close proximity of the source, there is a greater density in the center of the film than at the edges. The great divergence of the rays at the edges likewise had the effect of spreading out the registration of the slots, and this effect, coupled with the diminution of intensity of the ray, made certain of the slots far from the center not visible on the film. Especial attention should, however, be given the five slots registered near the center. The third arrow from the top indicates the photographic result from Slot No. 3 in Figure 18, which was 1 mm. wide by 2 mm. deep. Under the conditions of this experiment, therefore, a defect 1 mm. wide and only 2 per cent of the total thickness deep was detected. The second arrow from the top indicates the photographic result of Slot No. 2. Slot No. 1 is only faintly indicated (top arrow) for the reasons stated above.

enhancing screens, special developing methods, and special film-inspecting methods.

To eliminate the fancies of the observer, exposure curves may be given to represent the proper exposures for a given degree of absolute blackening of the film. The abso-

light is measured thermoelectrically. The degree of blackening, or density, is then given by the expression

$$D = \log_e \frac{I_0}{I} = 2.3 \log_{10} \frac{I_0}{I}$$

where  $D$  = density,  $I_0$  = intensity of primary beam, and  $I$  = intensity of transmitted beam.

A density of  $D = 1.15$  is sometimes taken as a satisfactory degree of blackening

$$x = \frac{1}{\mu} \log_e kt$$

where  $x$  is the thickness,  $t$  is the time of exposure required for a given blackening



Fig. 20. Steel casting 1 in. thick, with cracks. See Figures 21 and 22 for radiographs.

for radiographic purposes.<sup>14</sup> This density refers to the increase in density above that of the unexposed but developed film.

Figure 5 gives such exposure curves for X-ray tubes operating with a tungsten target<sup>15</sup> at the indicated voltages (D. C.). There is at present no exposure curve available for  $\gamma$ -rays.<sup>16</sup> Neglecting scattering and non-homogeneity of wave length, an exposure curve should have a slope inversely proportional to the linear absorption coefficient of the ray used (when plotted in the usual way, thickness against the logarithm of milliamperere-seconds). Mathematically

(for a constant tube milliamperage in the case of X-rays or for a constant millicurie strength in the case of  $\gamma$ -rays),  $\mu$  is the linear absorption coefficient as before, and  $k$  is a constant depending upon experimental conditions. A change in  $\mu$  is, therefore, much more effective in changing  $x$  than a change in  $t$ , since the logarithm of  $t$  changes very slowly with  $t$ . In other words, to increase the thickness range in radiography, a decrease in wave length is much more effective than an increase in time. To illustrate: Consider the difference in exposure time for 3 inches and 6 inches of iron. From Figure 5 the exposure time for 3 inches with a 220,000-volt X-ray tube is 3,000 milliamperere-seconds (50 milliamperere-minutes), requiring an exposure time of about 10 minutes at a milliamperage of 5. Extrapolating the exposure curve for a 220,000-volt tube

<sup>14</sup>In Briggsian logarithms a density of 0.5.

<sup>15</sup>Adapted from "Der gegenwärtige Stand der Röntgen durchstrahlung von Metallen," Siemens-Reiniger-Verlag, Berlin, 1928.

<sup>16</sup>Some attempts were made to procure such curves by a technic which later proved inadmissible. It is hoped shortly to obtain exposure curves to be used in practical  $\gamma$ -ray radiography. The radiographs reproduced in this paper are not of uniform density, nor are they all of the lowest practicable density, so that the exposure times cannot be taken as a guide except in a rough way.

type D. E. Q.<sup>19</sup> Readings were taken with a Leeds and Northrup galvanometer.<sup>20</sup>

A lead block with a longitudinal hole was placed between the  $\gamma$ -ray source and the ionization chamber, and served to define a

be necessary, requiring very high sensitivity in the ionization apparatus. In addition, extremely good insulation would be required, a troublesome matter.

Since these experiments were made tech-

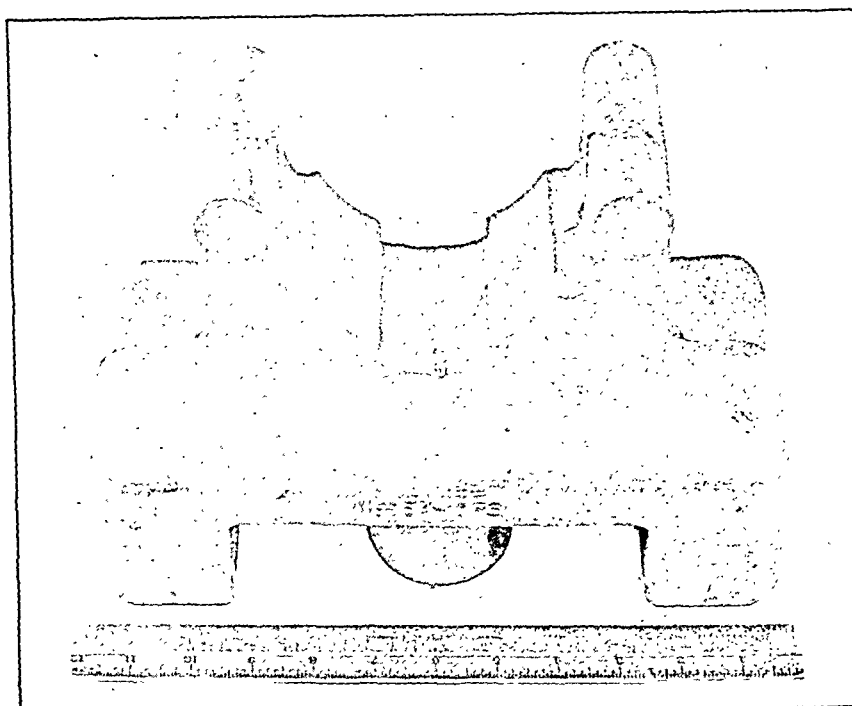


Fig. 23. Bronze casting radiographed in Figure 24.

beam half an inch in diameter. Steel blocks of different thicknesses were placed between the lead block and the source. With a 218-millicurie source 10 inches from the front of the ionization chamber it was just possible to detect (in the ionization current) the difference between 7 and 8 inches of steel. In other words, a hole 1 inch deep and  $\frac{1}{2}$  inch in diameter could have been detected in 8 inches of steel. Continuing, it was found that a difference could just be detected between 5 and  $5\frac{1}{2}$  inches of steel.

In any ionization method the width of the chamber slit is a limiting factor. To detect small imperfections a very narrow slit would

be necessary in the measurement of small currents has been developing rapidly. It is now possible to measure currents smaller than these with rugged and portable equipment. Any comparison of these results with the photographic results so far as sensitivity is concerned would accordingly be premature.

In order to obtain a record of the opacity of an object by any ionization method it would be necessary, however, to scan the area studied and to chart the variations in ionization current obtained. Such a method would be troublesome, though possibly some automatic scanning device might be worked out.

(b) As noted in the beginning of the paper, thin sections of metal had been radi-

<sup>19</sup>Amplification factor 20; impedance 100,000 ohms.

<sup>20</sup>Sensitivity 0.7 mm. per microvolt; 46 ohms resistance; 100 to 500 ohms shunt.

ated by means of  $\gamma$ -rays and the emergent beam observed upon a fluorescent screen years ago by Rutherford. Repetition of this experiment showed the effect to be striking. A moment's consideration, how-

#### RADIOGRAPHY BY MEANS OF $\gamma$ -RAYS

In all, several hundred photographs were taken of divers objects. The authors had at their command the radiographic technic

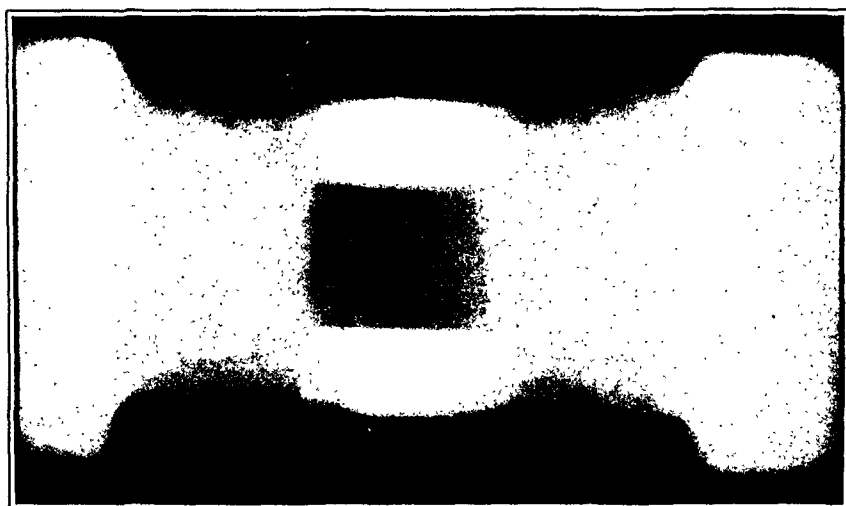


Fig. 24. An irregular bronze casting, a photograph of which is shown in Figure 23 (Film No. 12). Distance, source to film, 26 in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Film exposed somewhat more than necessary. Exposure time and strength of emanation could have been further reduced by the use of Patterson screens. Absorption of bronze is greater than that of steel, requiring a somewhat stronger source or a somewhat longer exposure time. A picture taken simultaneously, with film between two sheets of lead foil, gave slightly better contrast but approximately the same density. Note the small flaw in the upper right-hand corner of the casting.

ever, is sufficient to discover the inadequacy in such a method, for only very thin sections may be successfully inspected and in such cases no radiographic method is needed unless it be the X-ray.

(c) Although at the beginning of this work it was thought that an ionization method of recording the emergent beam was to be preferred because of the speed with which a record might be obtained, it was found that the photographic method yielded surprisingly good results and the work continued by this method entirely. Agfa and Eastman double-emulsion X-ray films were used exclusively.

so completely developed for X-rays, but little use was made of many of its details, for, in a pioneer attempt, such as this, it is more economical of time to discover a few essential facts before much endeavor is made towards refinement. Of these many photographs only a selected few are reproduced here, chosen to demonstrate the general nature of the results obtained. The chronology of the experiments performed was not that indicated by the sequence of photographs in this paper, so that there is lacking the indication of improved quality, resulting from experience, observed during the course of the work.



Without any initial conception of exposure times it was inevitable that many photographs should show too little or too much exposure. This may be noted even in the photographs reproduced here, with a

hanging screen, some using a Patterson calcium-tungstate screen, and some using a lead backing as an enhancing screen.

For these various reasons the exposure times noted for the various photographs

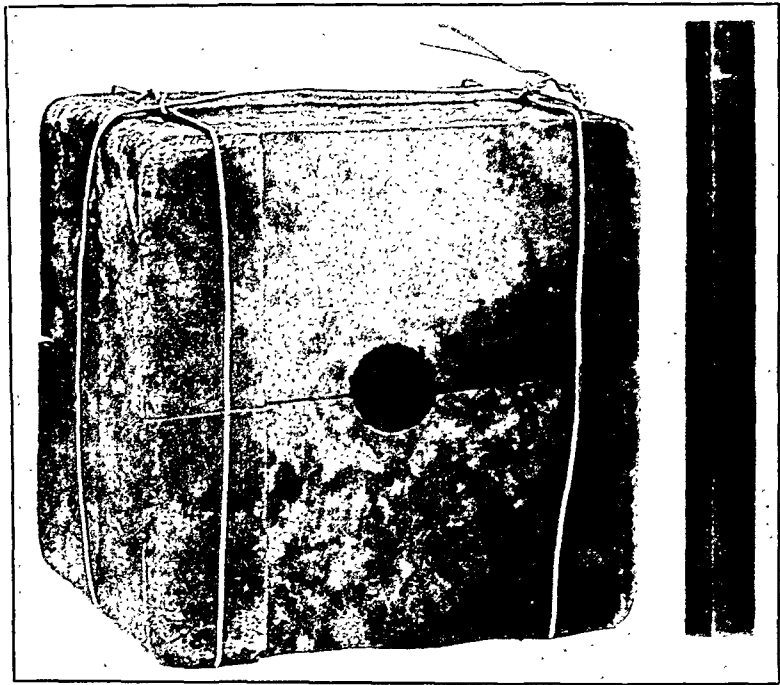


Fig. 25. Block of cast iron with a large hole leading off one face. Assembled after cutting and radiographed in Figure 27.

tendency toward over-exposure. For obvious reasons the shortest possible exposure time is desired. Some films were exposed "plain," that is, without the use of an en-

hancing screen, some using a Patterson calcium-tungstate screen, and some using a lead backing as an enhancing screen. For these various reasons the exposure times noted for the various photographs

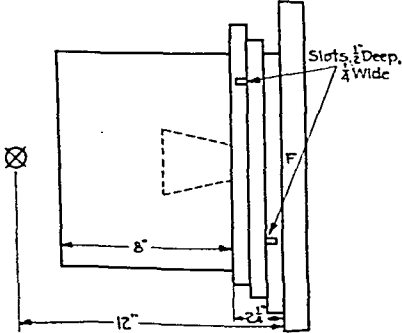


Fig. 26. Diagram of method of preparing specimen shown in Figure 25 and radiographed in Figure 27.

must be regarded carefully.<sup>21</sup> Considering also the fact that most of the films were over-exposed it is obvious that the exposure times noted could have been less.<sup>22</sup>

The specimens radiographed were chosen to represent the important features commonly found in radiography. They include "synthetic" specimens, that is, specimens built up of plates with holes, slots, and so

<sup>21</sup>Estimations of this reduction in exposure time vary. The booklet, "Der gegenwärtige Stand der Röntgendurchstrahlung von Metallen," published in 1928 by Siemens-Reiniger-Verlag, states (page 9) that the exposure time may be shortened to from  $\frac{1}{8}$  to  $\frac{1}{100}$ , dependent upon the wave length of the ray, the shorter rays giving a proportionately greater saving in time. This would indicate a great saving for  $\gamma$ -rays but as yet no determination has been made.

<sup>22</sup>It is obvious that any development in photography toward shortened exposure times would be of the greatest importance to  $\gamma$ -ray (or X-ray) radiography. Recent experiments in this Laboratory indicate the development of a method which will reduce the exposure time to at least one-half of that now necessary.

on, simulating cracks, voids, and inclusions actually found as defects in metallurgical materials. It was considered best to work first with such synthetic specimens, since the utter lack of previous work made all results

nic is extraordinarily simple. Many of the photographs were taken upon the table illustrated in Figure 6. The thistle tube rising from the center of the table held the radium emanation. Specimens were dis-



Fig. 27. The block of cast iron shown in Figure 25, with three  $\frac{3}{4}$ -in. steel plates, with slots, as shown in Figure 26. Distance, source to film, 12 in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Exposure of film nearly correct. Photographic reproduction of Film No. 13 made by photographing film laid upon sheet of white paper. This was found to be a very satisfactory way of viewing negatives that are not too dense. The large hole is very clearly visible; also, the slots in the plates may be seen to right and left of the large hole, indicated by arrows. Exposure time and strength of emanation could have been reduced considerably by the use of Patterson screens. A 1-in. hole in the top and another in the bottom were drilled after taking the radiographs, to facilitate cutting up the specimen, so that naturally they do not appear in any of the radiographs.

uncertain. In addition to such specimens there are included radiographs of a cast iron block with defects, a steel casting with surface cracks, a steel casting with sand inclusions, a bronze casting, and two imperfect welds.

It should be clear, from what has been said, that the necessary equipment and tech-

tributed radially around this, as indicated by the guides on the table top which served to orient the specimens and the photographic film holders. The technic of taking  $\gamma$ -ray radiographs consisted simply in mounting the metal object to be photographed upon the stand (if the stand were used), aligning it with the thistle tube, adjusting the holder

containing the film at the rear of the object, lowering the metal capsule containing the bulb of radium emanation in the thistle tube, and receiving the film holder at the

is, spherically. In appraising the cost of such a method of inspection this feature must be remembered.

#### γ-RAY RADIOGRAPHS

The descriptive matter accompanying the radiographs needs a word in explanation.

The technic described in the third paragraph above was always used, except that certain objects were photographed upon the floor. Diagrams of the relative positions of the emanation, object, and film holder are given only when necessary.

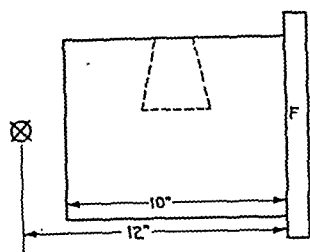


Fig. 28. Diagram of method of preparing the specimen radiographed in Figure 29.



Fig. 29. Same as with Film No. 13 (Fig. 27), except without steel plates. Hole on the side of casting, as shown in Figure 28. Distance, source to film, 12 in.; intensifying screen, one Patterson screen; time of exposure, 8 hrs.; mean strength of emanation, 1,150 millicuries in two bulbs. *Results:* Original film imperfect, giving a "spotty" radiograph. The hole in the side is clearly visible, but distorted owing to divergence of the beam. Film is badly over-exposed.

expiration of the exposure time. The films used and the developing procedure were similar to those in X-ray radiography.

It is an important feature of this method that many specimens may be arranged around the  $\gamma$ -ray source, for the radium emanation emits  $\gamma$ -rays in all directions, that

"Distance, source to film," refers to the distance, in inches, from the bulb of radium emanation to the film holder. The information listed after "intensifying screens" is self-explanatory, as is that after "time of exposure." "Mean strength of emanation" refers to the radiating strength of the

emanation half-way through the exposure. The strength of the emanation was, therefore, somewhat greater at the beginning of

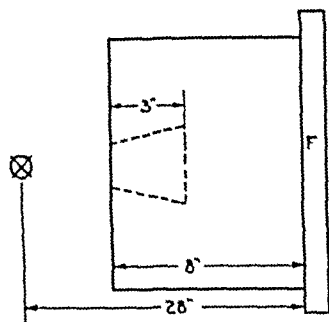


Fig. 30. Diagram showing method of preparing specimen radiographed in Figure 31.

the exposure and somewhat less at the end than that of the value given (see Fig. 1).

Under "Results" are listed a few essential features in the radiograph to which it is desired to call attention. Several of the  $\gamma$ -ray radiographs are accompanied by X-ray radiographs of the same object for purposes of comparison.

The radium emanation was held in a small ( $\frac{1}{8}$  inch in diameter) glass capsule, enclosed in a brass sheath,  $\frac{1}{2}$  inch in length,  $\frac{3}{16}$  inch in diameter. In several cases, when strong sources were used, more than one of these containers were used, as will be noted. The use of several containers is not to be recommended in general, since it increases the dimensions of the radiating source and, therefore, operates against a high degree of definition in the resulting radiograph.



Fig. 31. Same as with Film No. 14 (Fig. 29). Hole towards source, as shown in Figure 30 (Film No. 15). Distance, source to film, 28 in.; intensifying screen, one sheet of lead foil; time of exposure,  $10\frac{1}{2}$  hrs.; mean strength of emanation, 2,181 millicuries in six bulbs. *Results:* Exposure greater than necessary. The larger hole may be clearly seen. In addition to this, there may be discovered in the original of Film No. 15 a cloud-like image floating over the large hole and downwards slightly to the right. This suggested a defect in the back of the block, which, upon cutting, was found—see Figure 32.

The usual difficulty in photographic reproduction of the original radiographs for publication was experienced, perhaps somewhat more severely, for the  $\gamma$ -ray radiographs do not show as great a contrast as

scientific fashion the use of  $\gamma$ -rays for the radiographic detection of defects in metallurgical material. It does not, therefore, present a finished testing method to industry; nor is there any attempt to analyze the

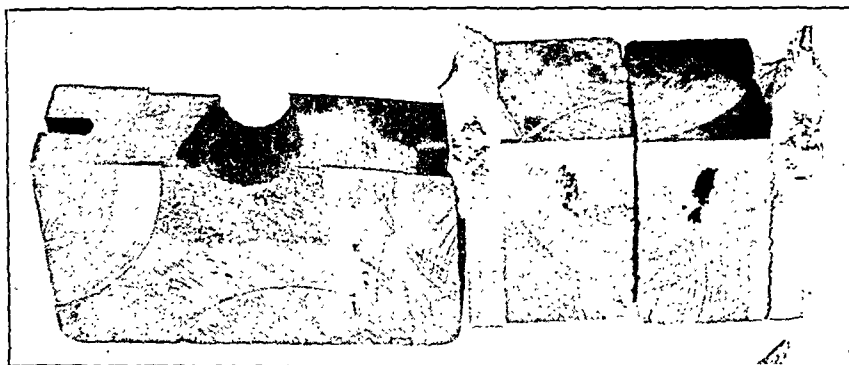


Fig. 32. Defects in block shown in Figure 31.

the ordinary X-ray radiographs. The films were mounted on wooden frames, inserted in a light-tight viewing cabinet, and photographed with a brilliant source of illumination at the rear. Best results were obtained with process plates (Wratten M) and with printing upon contrast paper (Azo glossy, usually No. 4). It is inevitable that the published reproductions of the original radiographs should be unsatisfactory. In each case under "Results" are given a few sentences comparing the reproduction with the original film.

The first three films, respectively of an echelon of steel plates, a lathe tool rest, and a wrench, were taken merely to test the sensitivity of the  $\gamma$ -ray radiographic method for detail. These are all within the X-ray range of thickness.

#### DISCUSSION AND SUMMARY

The aim of the present work may be stated in simple terms: it is an attempt to appraise in a preliminary and in a purely

economics in any possible commercial exploitation. This latter task must be left to those whose interest might make such a testing method desirable.

The results attained are those illustrated by the  $\gamma$ -ray radiographs and itemized under "Results" in the appended descriptions. To complete the appraisal possible at this time these results should now be recapitulated; and, furthermore, the practical features surrounding the use of a  $\gamma$ -ray method of inspection should be set forth.

The physics of  $\gamma$ -rays (developed from the standpoint of radiography) in the Introduction indicates that  $\gamma$ -rays, because of their shorter wave length (Fig. 2) and correspondingly lower absorption coefficient, should be able to penetrate thicknesses of metal with a smaller loss of intensity than X-rays, and, moreover, for the same reason, should not require for great thicknesses the relatively tremendous increase in exposure time characteristic of the X-ray wave lengths now commonly in use.

It is a corollary that the transmitted beam

should register defects upon a photographic film with a contrast inferior to that obtained with the present radiographic X-ray wave

lengths. This diminished contrast is an inevitable resultant of the shorter wave length, and is, of course, not peculiar to the radia-

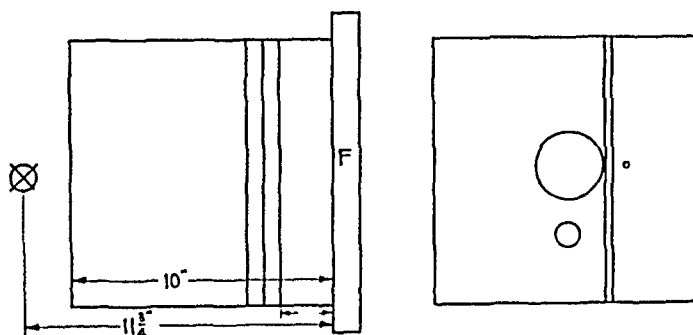


Fig. 33. Diagram showing method of preparing specimen radiographed in Figure 34.

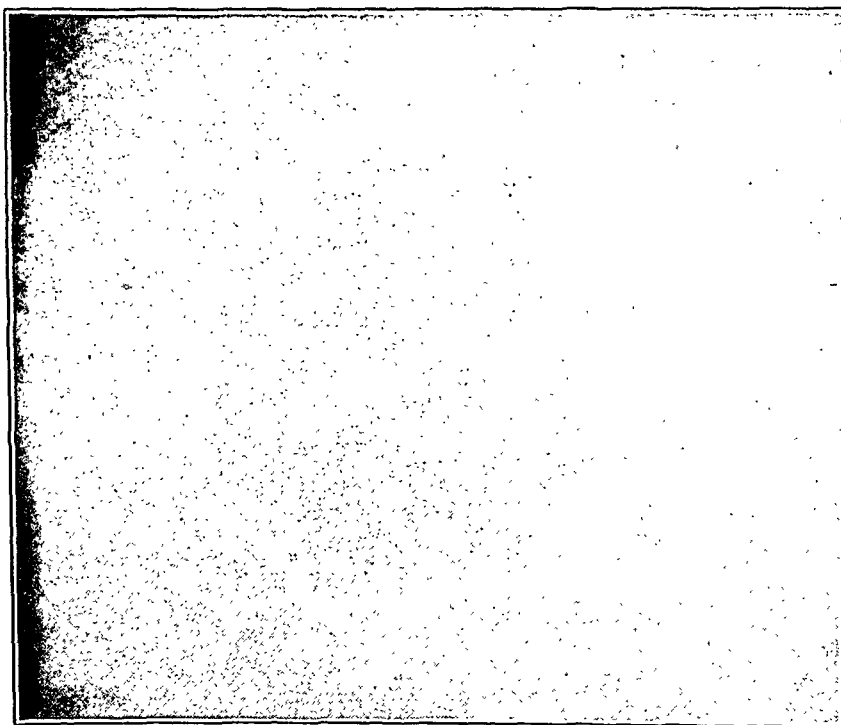


Fig. 34. Pile of steel plates, total thickness 10 in., with holes and slots in two plates, as indicated in Figure 33. The positions of the two plates bearing the holes and slots are indicated in the 10-in. section in Figure 33. The rest of the section was made up of plain plates (Film No. 16). Distance, source to film,  $12\frac{1}{4}$  in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Under-exposed. Another film, taken simultaneously with two Patterson screens, had nearly correct density for viewing by reflected light when backed by white paper; by mistake, the poorer of the two was sent for reproduction (authors' note). On both, the hole 3 in. in diameter by  $1\frac{1}{2}$  in. deep is shown clearly, while the hole 1 in. in diameter by  $1\frac{1}{2}$  in. deep is barely seen. On the better film both slots are faintly recorded. The  $\frac{1}{4}$ -in. holes do not appear. A single bulb, with a correspondingly longer time, would have considerably improved the definition in this and several other films.

tion originating from the decomposition processes in radium emanation; development of higher voltage X-ray radiography would lead to a similar circumstance.

It was also indicated in the Introduction

As to be expected, enhancing screens (of calcium tungstate) are very effective in reducing exposure times, though the actual saving in time has not been defined. Lead foil likewise proved effective in shortening

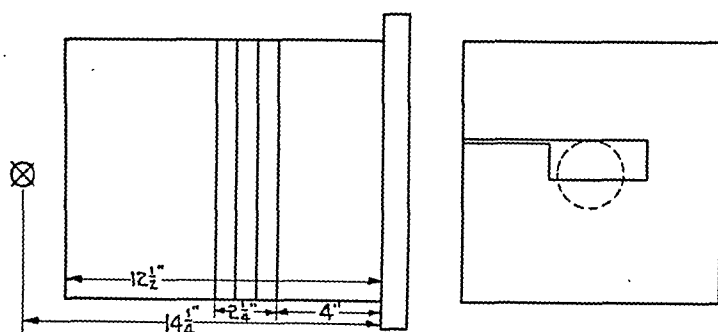


Fig. 35. Diagram showing method of preparing specimen radiographed in Figure 36.

that the scattering of  $\gamma$ -rays (Fig. 4) should not be inimical, and that, in fact, the almost complete absence of "back-scattering" (scattering at an angle of 180 degrees and thereabouts to the primary beam) is an especially favorable feature of  $\gamma$ -rays, for it is unnecessary to take the precautions (various types of shielding) which are a necessary part of X-ray radiography. It may be said that the experiments performed appear to bear out these views.

Radiographs have been taken of objects the thickness of which exceeds that thickness now possible to radiograph with X-rays within reasonable exposure times, that is, from four to ten inches of steel. The minimum exposure times for such thicknesses have not been defined. If it should appear desirable to develop a  $\gamma$ -ray radiographic method for practical use, it will be necessary to work out a correlation of strength of source, time of exposure, and photographic result. In such an eventuality especial attention will have to be given to methods by which the exposure time, at best rather long with  $\gamma$ -rays, can be reduced to a minimum.

exposure times. The use of multiple films is effective in making visible to the eye dimly developed images, and this technic is to be recommended to eliminate from consideration possible spurious effects originating in defective films. It has been found very useful to view the developed film in good light upon a piece of white paper. The enhancing effect of this device is startling. Film No. 13 (Fig. 27) was photographed in this way.

The diminished contrast is illustrated especially by Figures 14 and 15 and Figures 21 and 22. This diminished contrast is not necessarily an argument against the use of  $\gamma$ -rays, especially in the upper ranges of thickness, but it means that importance must be given to slight density discontinuities on the developed film. No detail shown in Figure 14 is absent from Figure 15; it merely appears with diminished contrast. This diminished contrast originating in a lower absorption coefficient has one advantage: it facilitates the radiography of irregular sections, for it is an easier matter with  $\gamma$ -rays to obtain the whole of an irregu-

lar object at a correct exposure than it is with X-rays. This, likewise, is shown by Figures 14 and 15.

Although no efforts were made to prevent scattering in these experiments, no poor re-

small defects seems satisfactory, though in the absence of extensive experimentation there may be some uncertainty on this score.

Despite the fact that Film No. 9 was taken upon a "synthetic" specimen, the certain



Fig. 36. A series of steel plates having a total thickness of  $12\frac{1}{2}$  inches. All the plates were plain except three near the center, as indicated in Figure 35. Two of these were the plates illustrated in Figure 33, the third illustrated on the right of Figure 35, which shows the alignment (Film No. 17). Distance, source to film,  $14\frac{1}{4}$  in.; intensifying screen, one Patterson screen on each of two films; time of exposure,  $10\frac{1}{2}$  hrs.; mean strength of emanation, 2,181 millicuries in six bulbs. *Results:* Under-exposed. The photographic reproduction was done with rear illumination with two films (taken simultaneously) superimposed. The films were held at an angle during reproduction in an attempt to bring out more strongly the dark area in the center. Within the range of intensities and exposure times available during these experiments, this film shows that the thickness for satisfactory radiographs has been exceeded. Our opinion is, however, that a longer exposure and a source of smaller dimensions would allow this and probably greater thicknesses to be radiographed.

sults were obtained which could be ascribed to this cause. Thus Films No. 3, 11, 15, and 17 were made simultaneously, as were Films No. 12, 13, and 16, with the objects close together and several of them of very considerable mass, yet fogging appears to be unimportant on these films. This, taken with the fact that portions of the film exposed to the primary beam are not so badly overexposed when  $\gamma$ -rays are used as when X-rays are used, explains the lack of halo at the edges of the specimens.

The sensitivity of the  $\gamma$ -rays towards

identification of a slot only 2 per cent of the total thickness is promising. The discovery of the defect in the cast iron block upon Film No. 15 was, of course, somewhat gratifying.

The above discussion is all built upon the photographic registration of the transmitted beam. For reasons already given it is believed that fluoroscopic methods are not feasible and that at present the photographic method is superior to methods by which the intensity of the transmitted beam is registered by means of its ionizing effect.



The practical features surrounding the use of  $\gamma$ -rays for radiography are so greatly different from those of X-rays that care must be taken in comparing practical application of the two methods.

The technic of  $\gamma$ -ray radiography is extremely simple. There is required merely a source of  $\gamma$ -rays of suitable strength (radium or radium emanation) mounted simply (Fig. 6, for example), the object to be radiographed placed at a suitable distance—defined by the strength of the source, the thickness of the object, the exposure time desired, and the definition required—and a photographic film, with or without intensifying screens, placed behind the object.

During the exposure no attention need be given and the operator may leave, returning at the expiration of the necessary exposure time. There is, of course, no high voltage equipment to be attended, nor are there any permanent high voltage leads to the source. In fact, the set-up could be arranged at almost any conceivable place, for everything is entirely portable and rugged.

The emission of  $\gamma$ -rays cannot be controlled. Whether or not the radio-active source is being used for radiographic purposes, it will continue to emit  $\gamma$ -rays. It would be advisable, therefore, to make as continuous use of the source as possible during the time it is in the possession of the operator.

Since  $\gamma$ -rays are emitted in all directions—that is, spherically—the source might be completely surrounded by objects to be radiographed. Because of the inverse square law governing the diminution of the intensity with distance from the source, it is unimportant whether a large number of objects be radiographed at a considerable distance with a long time of exposure, or a small number at a short distance with a brief time of exposure; in either case the profitable use made of the  $\gamma$ -ray would be the same, with the qualification that a greater

degree of definition would be obtained at the greater distances.

With a constant source of  $\gamma$ -rays and a large number of objects of varying dimension to be radiographed suitable exposures might be obtained either by varying the time of exposure, or by placing the thinner objects at greater distances and keeping a constant time of exposure for the whole arrangement. This latter scheme was followed in preparing Films No. 3, 10, 15, 17 and Films No. 12, 13, 16.

In the use of  $\gamma$ -rays, as in the use of X-rays, protection must be given the operator against the harmful effects of the rays. It would hardly be useful here to describe in detail the precautions the medical profession has found necessary, except possibly to mention those affecting the technic of operation. Distance, of course, is the best protection, and since no attention during exposure is required, this requirement may easily be met. The emanation is usually transported in a small but heavy-walled lead box and the emanation handled with forceps. These are probably the only details to be mentioned. The authors have been assured by medical practitioners that there should be no objection to the use of  $\gamma$ -rays for the purpose suggested here, originating in possible harmful effects to the operator.

#### ACKNOWLEDGMENT

The authors wish to express their obligation to a number of persons who rendered valuable assistance during the course of this work: to Dr. Howard A. Kelly, of the Howard A. Kelly Hospital, Inc., of Baltimore, Md., who granted us permission to make use of his supply of radium emanation, and especially to Dr. F. West, Superintendent of the hospital, who attended to our various needs during the work with the greatest of consideration and helpfulness; to Prof. A. F. Kovarik, of the Department of Physics, Yale University, who discussed the problem with us previous to the begin-

ning of the work; to Dr. H. H. Lester, of the Watertown Arsenal, Watertown, Mass., who rendered assistance from time to time during the work; to Prof. J. B. Hoag, of the Department of Physics, University of Chicago, who made some preliminary ex-

periments for us upon photography with  $\gamma$ -rays; to J. T. Gow, of this Laboratory, who lent assistance in many ways during the prosecution of the work, and finally, to Captain E. G. Oberlin, U. S. N., whose sympathy with research made this work possible.

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The Radiophysiological and Medical Sections of the Radium Institute of the University of Paris. Cl. Regaud. *Radiophysiologie et Radiothérapie*, 1930, Vol. II, Fasc. 2, p. 157.

The main value of this paper lies in a detailed discussion of the requirements for an efficient organization for the treatment of disease by radiations. The author emphasizes the fact that X-ray diagnosis and therapy are separate and distinct branches of medical science, while X-rays and radium are ever becoming more closely associated, particularly in the treatment of malignant disease. It is undesirable that an institute for radiation

therapy should be limited to the treatment of cancer, but benign conditions which are capable of radiation treatment should also be included. The organization should include an efficient pathological and experimental service, and facilities should also be available for surgery. All departments should be under the control of specialists in the appropriate branches. Finally the necessity is stressed for a well organized secretariat which should have charge of all the clinical, pathological, and other notes relating to all patients, and should be responsible for insuring the regular follow-up of patients.

WALTER M. LEVITT, M.B., D.M.R.E.

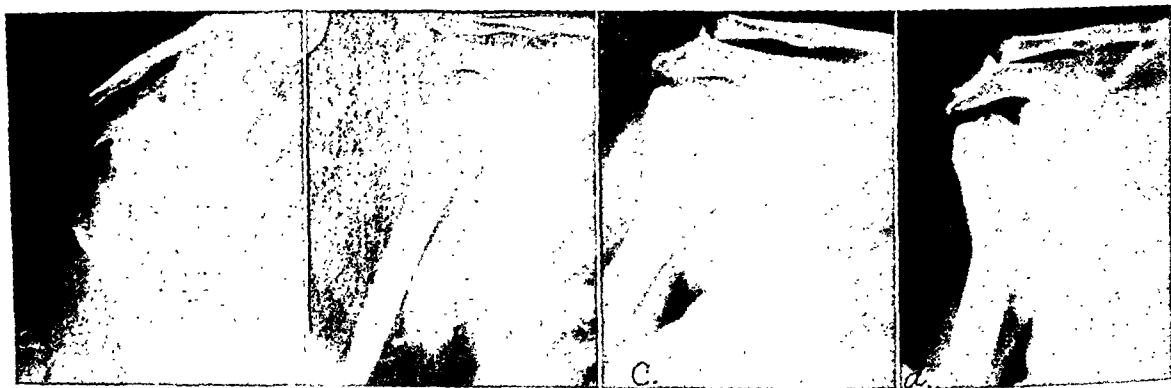
## X-RAY TREATMENT OF BONE METASTASIS<sup>1</sup>

By CASSIE B. ROSE, M.D., Presbyterian Hospital, CHICAGO

ALL investigators agree that the best treatment of malignancy now known is early and complete removal when this is possible. Since this is, every so often, impossible, many other methods of treatment have been devised. Of all the therapeutic measures, other than surgery, which have been tried, such as caustic pastes, active cautery, various sera, etc., radiation in the form of X-ray and radium

mental and physical. Radiation surely gives relief from pain, together with hope and mental comfort to many of these unfortunate sufferers, ever increasing in number, even though it may not produce permanent cures.

In 1916, Pfahler, of Philadelphia (2), first reported cases in which, following radiation therapy, bone destroyed by metastatic carcinoma recalcified, with corre-



Figs. 1-A, 1-B, 1-C, and 1-D. Case 1. Metastasis in the head of the humerus from breast carcinoma, showing progressive evidence of calcification.

has taken an outstanding place and seems to offer the most hope. It has proved so efficacious in skin cancer that it effects real cures in more than 90 per cent of the cases, when given fairly early and in sufficient dosage. The cure of deep-seated cancers by radiation has not yet been solved. The combination of radiation with surgery gives from 25 to 30 per cent better results in all types of cases than surgery alone, according to the statistics of various clinics (1).

Medicine should *relieve suffering*, both

sponding clinical improvement. A few similar cases have been reported since.

I believe it is well to re-emphasize this effect of radiation.

My experience with metastatic carcinoma in bone either from breast, prostate, or other source, includes 50 cases. In analyzing the results, I have satisfied myself that, although this treatment does not cure, it prolongs life and relieves the sufferers of their pain to a surprising extent and often makes them able to enjoy life and participate in the activities of their home or even their business to such an extent that they feel the X-ray treatment has put them on

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-3, 1930.



Fig. 2. Case 1. Multiple metastases in many bones.

their feet again. Out of this group of 50 cases I want to present to you a few as examples. All of these patients were in the Presbyterian Hospital, Chicago.

#### CASE REPORTS

Case 1. Mrs. G. T. was referred by Dr. D. B. Phemister. Tuberculous glands of the neck had been removed when the patient was 17 years of age, and again when she

was 21 years old. When she was 36 years old her right breast was removed for carcinoma, proved microscopically. Six years later, that is, in 1924, she complained of severe pain in the left shoulder, at which time



Fig. 4. Case 2. Destruction in the left scapula, said to be a rare site for bone metastasis.



Fig. 3. Case 1. A pathologic fracture in the humerus, just below the old area of sclerosis.

X-ray examination showed destruction of the head of the humerus, undoubtedly a metastasis (Fig. 1-A). After two months of X-ray treatment, a film showed evidence of calcification. Subsequent films showed rapidly increasing sclerosis in the involved area (Figs. 1-B and 1-C). The patient's pain disappeared and she was able to use her arm normally; for instance, she could drive her car, can fruit, and sweep the floor.

Two and one-half years later, February, 1927, a roentgen film and clinical examination showed persistence of this good result (Fig. 1-D). In the Summer of 1927, while on an extended trip, the patient became lame and suffered from fleeting pains in various

parts of the body. Films taken in October showed multiple metastases to many bones (Fig. 2). Further X-ray treatment effected some recalcification, but never as marked as in the humerus and later some of it disap-

peared again. freedom from pain instead of severe disability.

Case 2. Mrs. H. S. was referred to me for X-ray treatment in November, 1927, by Dr. H. L. Kretschmer. Two years after

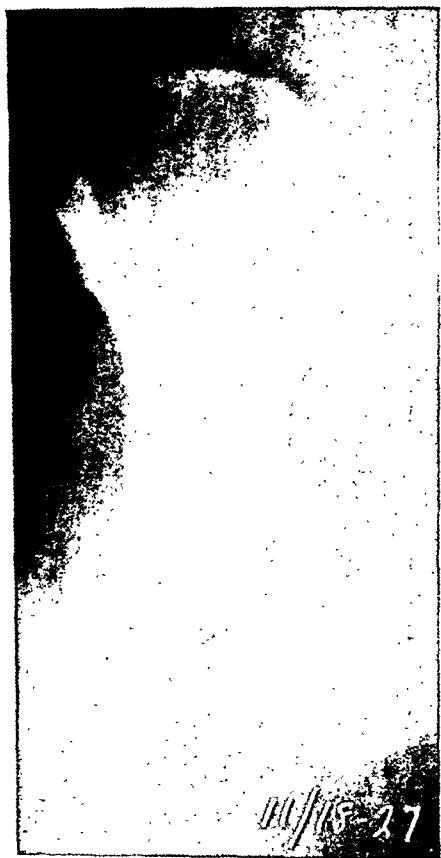


Fig. 5. Case 2. Right ilium, showing metastasis.



Fig. 6. Bone repair in Case 2.

peared again. A pathologic fracture occurred in the humerus, just below the old area of sclerosis (Fig. 3). Although the patient was for the most part fairly comfortable, slept well, and retained her appetite, she went gradually downhill and died in February, 1929,—eleven years after her breast removal and four and one-half years after the bone metastasis was found in the left humerus. It would seem that the X-ray treatment during these four and a half years gave usefulness and comfort and

breast removal, severe pain appeared in the left shoulder and X-ray examination showed destruction in the left scapula (Fig. 4), said to be a rare site for bone metastasis (3). In addition, the third lumbar and the right ilium showed metastasis (Fig. 5).

Bone repair occurred with fair rapidity, with corresponding improvement in clinical symptoms (Figs. 6, 7). During 1928 she was comfortable and able to look after her home and children. Recurrence, with loss of calcification and extension of the previ-

ously involved areas, occurred in 1929 (Fig. 8), with death in September of that year, two and a half years after the metastasis was discovered, and two years after X-ray therapy was instituted. During this time she was greatly relieved of her suffering, due, so far as I can see, to X-ray therapy.



Fig. 7. Bone repair in Case 2.

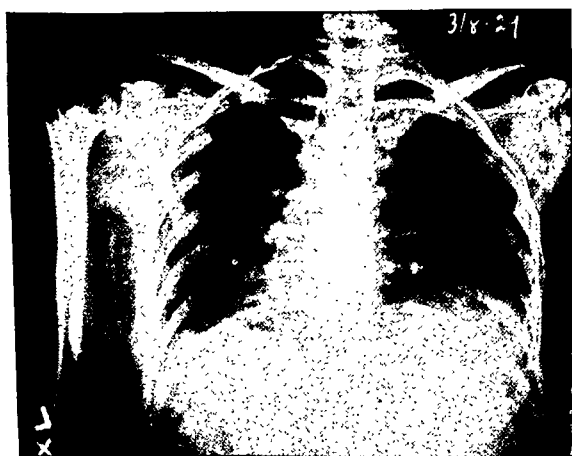


Fig. 8. Case 2. Recurrence, with loss of calcification and extension.

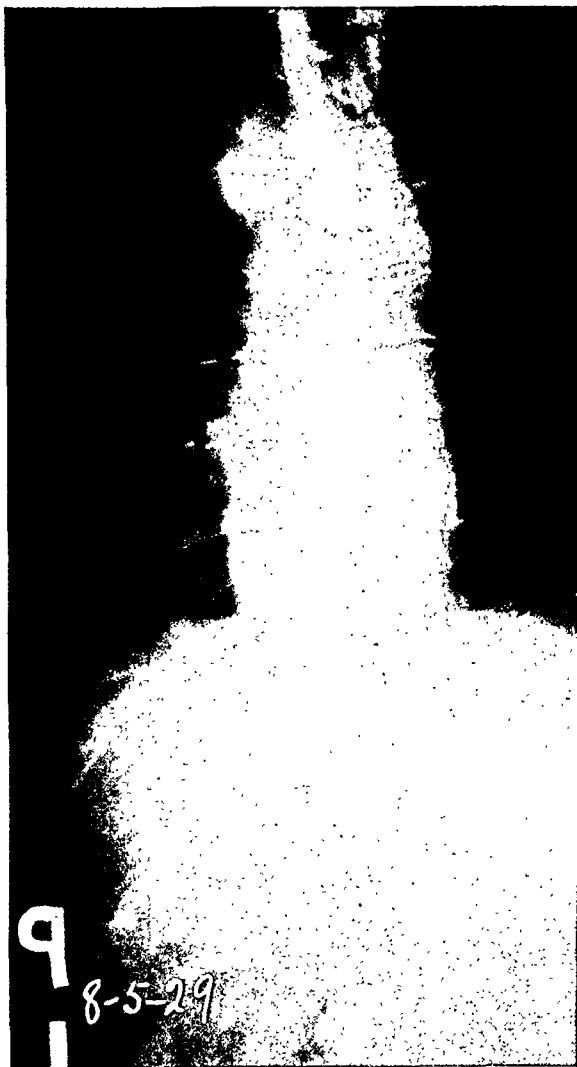


Fig. 9. Case 3. Partial collapse of the last three dorsal vertebrae, particularly the eleventh, and a fracture of the eleventh rib on the left, close to its articulation with the spine.

Case 3. The patient, Miss J. B., in December, 1913, five years after she had first noticed a bean-sized nodule in the right breast, had a radical resection done by Dr. A. D. Bevan, for carcinoma (proved microscopically). The nodule at this time was the size of an egg, and the axillary glands were involved. A few X-ray treatments were given post-operatively.

Ten years later, in 1923, the patient noticed a small nodule in the left breast. This grew in two years to the size of an English

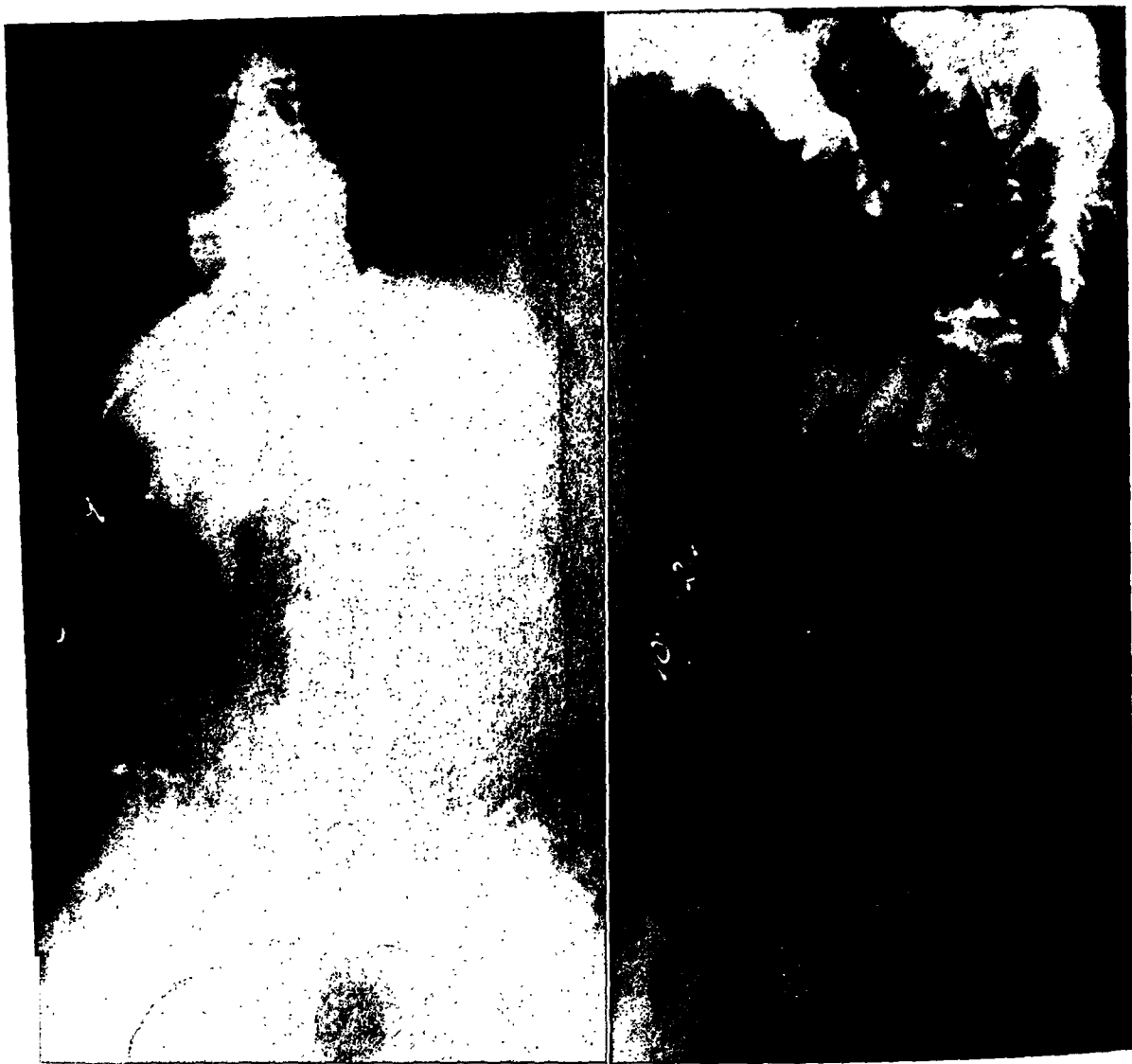


Fig. 10. Case 3. Following X-ray treatment, there was some increase in the density of the vertebræ.

walnut. In May, 1925, a radical resection of the left breast was done by Dr. Gatewood, and at the same time a recurrence in the right scar was removed. Again X-ray treatments were given, followed by a second series in 1926. In October, 1927, and June, 1928, a dime-sized recurrence appeared in the right scar, and each time disappeared following a short course of radiation. In January, 1929, this area again appeared and ulcerated and neither X-ray nor radium sufficed to close it entirely. In

June, 1929, the patient developed pain in the legs, with difficulty in walking. In August an X-ray film (Fig. 9) disclosed partial collapse of the last three dorsal vertebræ, particularly the eleventh, and a fracture of the eleventh rib on the left, close to its articulation with the spine. After X-ray treatment the pain disappeared and films (Fig. 10) showed some increase in the density of these vertebræ. The patient returned to her work, but a month later the pain recurred, she became progressively



Fig. 11. Case 3. Autopsy specimens.

weaker, was confined to bed, but was fairly comfortable under mild sedatives. She died in April, 1930, twenty-two years after she had first noticed a nodule in her breast. A definite, although short, relief from pain and disability in walking was obtained through X-ray therapy, and there was some reformation of bone tissue.

Postmortem (Fig. 11) showed pathologic fracture of both femurs and carcinomatous involvement of the spine, together with multiple miliary metastases in many parts of the body. Microscopically, small spicules and buds of new bone were visible in the previously collapsed and radiated dorsal vertebræ. It is impossible to state whether this new bone was the result of X-ray therapy, or simply callus following fracture. In three other patients with similar metastatic involvement, who did not have X-ray therapy, such bone buds were not seen. Further study of postmortem evidence is needed.

Case 4. Mrs. C. D. was a patient of Dr. W. E. Post. Two years subsequent to the removal of the left breast, this patient, aged 36, delivered a full-term baby. In the latter



Fig. 12. Case 4. Bone destruction.

part of the pregnancy she complained of much pain in the pelvis and legs and was unable to walk. This was interpreted as pressure pain. However, it did not dis-



Fig. 13. Case 4. Calcification in areas of bone destruction.





Fig. 14. Case 4. Evidence of calcification.

appear after the delivery but grew progressively worse. The patient became unable to turn in bed without help, and then only with excruciating pain. Opiates gave only partial relief.

X-ray films (Fig. 12) taken in July, 1928, showed bone destruction of the left side of the sacrum, the right acetabulum, the third, eighth, eleventh, and twelfth dorsals, and first lumbar, also complete erosion with fracture of the seventh and eleventh ribs and many other small areas of rib involvement. In August, 1928, the patient was referred to me for X-ray therapy. Rapid relief of pain and calcification in the areas of bone destruction followed. In October she was comfortable; in March, 1929 (Figs. 13, 14), she was walking with a cane; a few weeks later the cane was discarded, and she was able to live her normal life. In January, 1930, she took a seventy-mile automobile ride without discomfort. Films at this time showed such complete regeneration of bone that the old areas of destruction were difficult to visualize.

However, carcinoma developed in the other breast, and numerous firm nodules appeared in the skin of the neck and abdomen.

Films (Figs. 15, 16, 17, 18) showed evidence of metastases to the bones of the skull, and the areas previously involved became a little less densely sclerosed, although the destruction was not nearly so marked as on the first films of this patient. In July she still was able to walk, though with less agility, and considerable nausea and vomiting had developed. On October 28, 1930, she died. During this time never more than four aspirin tablets in twenty-four hours were needed to control her pain, and on some days none were needed. No morphine was given except one dose the day before her death. At no time did she lose her *morale*. She had two full years of comfortable and useful life, instead of being bedridden and tortured with excessive pain, and I believe that the X-ray should be credited with this good result. Autopsy was not permitted.

Case 5. Mr. F. H. was a patient of Dr. H. L. Kretschmer. He was a man 74 years of age, who entered the hospital in March, 1927, complaining of prostatic symptoms of four or five years' duration and recent pain in the right leg, with difficulty in walking. A large hard nodular prostate was found. X-ray films taken in March, 1927 (Fig. 19), showed extensive destructive metastasis to the right side of the pelvis. A suprapubic cystotomy was done and X-ray therapy was started. Within two months the pain had disappeared and the patient went home. He returned six months later (in December, 1927), with recurrence of pain in the right leg. X-ray films (Fig. 20) showed some—not very marked—increased calcification in the previously involved area. Further X-ray treatment was given. Following this for a year the patient was perfectly comfortable and able to carry on his usual work, which involved many long motor rides. In December, 1928, he returned with pain in the left leg, but no pain had recurred in the right leg. A series of X-ray treatments re-

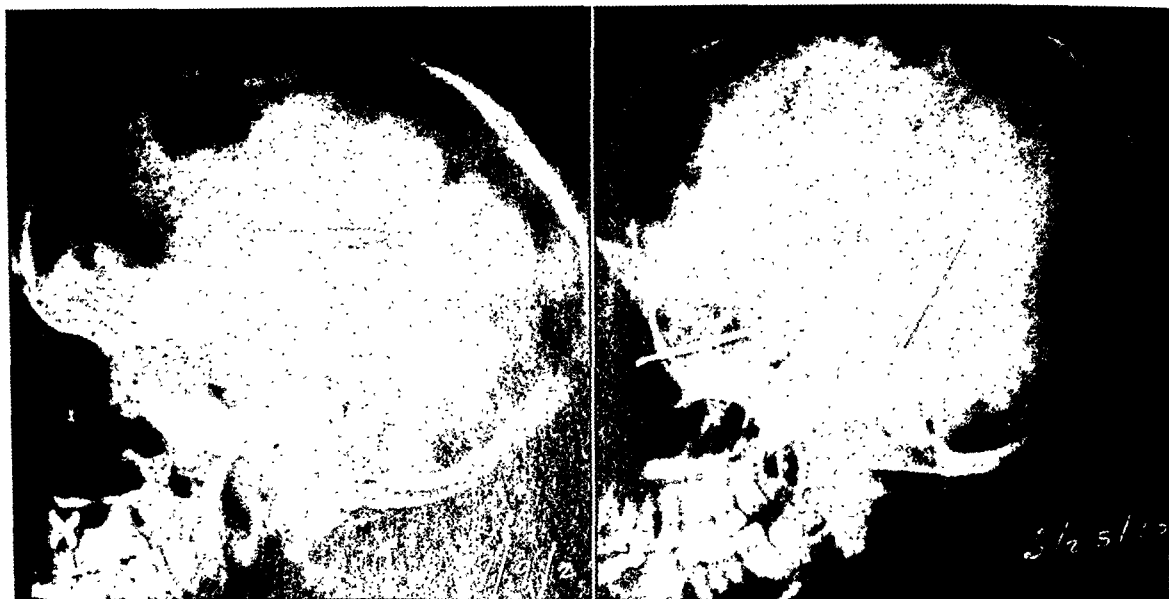


Figs. 15 and 16. Case 4. The areas previously calcified are less densely sclerosed.

lieved the pain. A film at the end of the treatment (Jan. 3, 1929) showed a heavy calcification in the right side, and numerous rounded areas of increased density in the left side of the pelvis (Fig. 21). Again he went home comfortable, but died some three or four months later. I believe the X-ray treatment gave to this man more than a year of comfortable, active business life which he would not otherwise have had.

Case 6. Dr. F. B., a patient of Dr. A. H. Montgomery, aged 61, was diagnosed in June, 1928, as having carcinoma of the prostate. Radium was given through the

perineum four times. In August, 1929 (Fig. 22), an X-ray film showed multiple small rounded areas of faintly increased density throughout the bony pelvis. At the same time the patient was in severe pain—unable to turn in bed without help and then only with great difficulty. Opiates were not tolerated. Pantopon was tolerated fairly well and gave some relief. X-ray treatment was started. Within two months the patient was able to walk up and down the corridor of the hospital. A film (Fig. 23) showed a marked increase in the density of the small rounded areas seen on a previ-



Figs. 17 and 18. Case 4. Evidence of metastases to the bones of the skull.

ous film of the pelvis. A film in December showed still further sclerosis of these areas (Fig. 24). The patient was able to go home but returned in March with a nephritis of severe degree, which terminated in uremia in April. The severe bone pain did

not return to any considerable degree. Subsequent films were not taken and autopsy was not permitted. I believe that the X-ray therapy gave this patient definite and

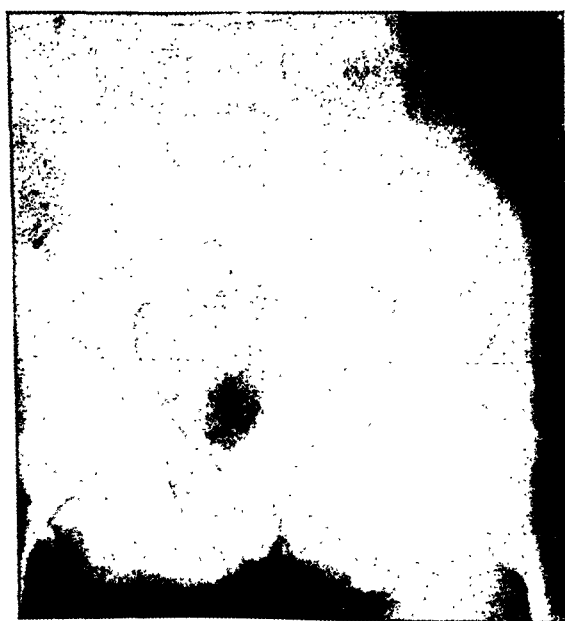


Fig. 19. Case 5. Extensive destructive metastasis to the right side of the pelvis.

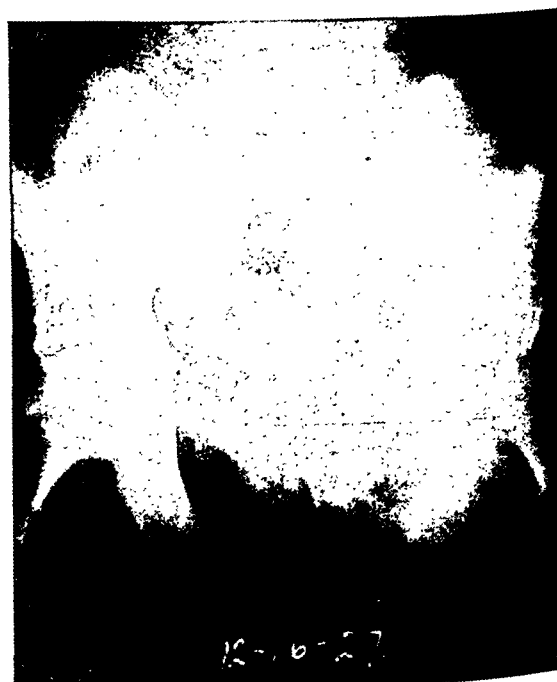


Fig. 20. Case 5. Some—not very marked—increased calcification in the previously involved area.



Fig. 21. Case 5. Film taken at the end of the treatment, showing a heavy calcification in the right side, and numerous rounded areas of increased density in the left side of the pelvis.



Fig. 22. Case 6. Multiple small rounded areas of faintly increased density throughout the bony pelvis.

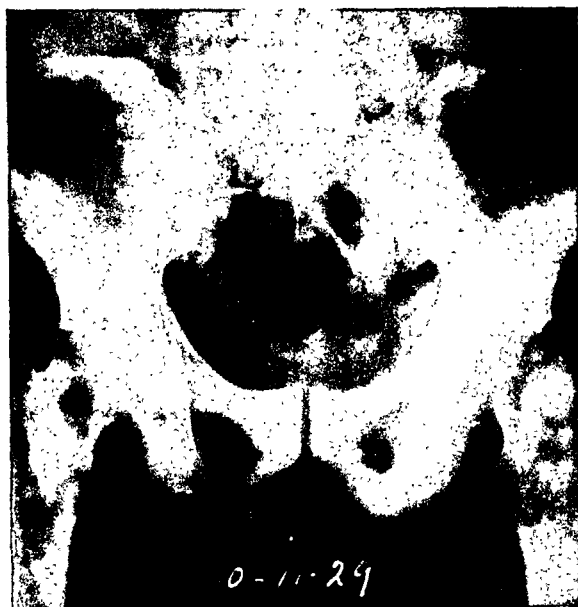


Fig. 23. Case 6. Marked increase in density of the small rounded areas seen in Figure 22.

very welcome relief from the pain, which he was unable to get from medication.

For all of these patients I have used a routine treatment dose: 140 kilovolts, peak; 5 milliamperes; 10-inch skin target distance;  $\frac{1}{4}$  mm. copper and 1 mm. aluminum filter; time, 10 minutes, covering an area 15 cm. in diameter. This dosage gives 35 r per minute. One area was radiated at each treatment, rarely two areas. Treatments were given, as a rule, two or three times per week, and were directed from various angles toward the areas of involvement. I did not treat the same area oftener than once in ten days or two weeks. Treatment was continued for a period of from four to six weeks, after which the patient was given a rest interval of from one to two months. After the patient became comfortable radiation was intermittent or even discontinued for several months. In one or two instances in which the patient came from a considerable distance, treatments were given daily for a period of two or three weeks.

Glucose, either intravenously or orally, usually in conjunction with calcium lactate,



Fig. 24. Case 6. Still further sclerosis of the areas shown in the previous figures.

was given to several of these patients for varying periods of time. In some instances it seemed to help, though I was never sure that it was of any considerable value therapeutically. If long continued, the patients developed a strong aversion to it. In the case with metastasis to the humerus, the patient was treated without glucose until the time of the late generalized metastases.

I am of the opinion that frequently repeated doses of X-ray of moderate voltage are sufficient, and, in the long run, give satisfactory results. In my experience comparatively little roentgen sickness has appeared.

Because clinicians in general and many roentgenologists seem to feel that when bone metastases occur the case is utterly hopeless, I am presenting these six cases as a plea that these patients be given the benefit of radiation therapy. This relief of suffering and the reformation of bone are the two factors which should make us look

upon X-ray treatment as the greatest boon to the patient until medicine shall have found a cure for this disease, a part of which may be X-ray.

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#### DISCUSSION

DR. FRANCIS CARTER WOOD (New York City): I think Dr. Rose's paper is an excellent illustration of the purely palliative type of treatment with which we are all familiar. I think she has well stressed the very important point not to use high voltage radiation, which makes these patients very sick and does not improve the lesion any more than does the use of a moderate voltage, which is easily handled and is at everyone's disposal. The cases which I have seen treated with high voltage have usually done badly. My own practice is about that of Dr. Rose, repeated low voltage treatments giving about 60 or 70 per cent of an erythema or some 400 r units. I can, of course, only agree with her that many of these cases do extremely well; patients are able to get back to work and are freed from the necessity of taking drugs, and a little aspirin or a similar sedative will often carry them along to within a few weeks of their death. It is rather interesting to note that these patients who get bone metastasis rarely get pulmonary lesions; the ones that get pulmonary lesions die early and we can do little for them. The trouble is we rarely get these patients until the bones are invaded, and after some practitioner has

treated the patient for rheumatism, and thus time is lost. Such patients should be turned over to the radiologist, given light doses of X-ray over the lesion to prevent skin recurrences, and kept under observation. Radiation should be begun before bone changes are shown. The bone change is late and means absorption of calcium salts, but many patients have their bone pains early, and,

if treatment is begun then, we get a much more satisfactory prolongation of life. The surgical profession is by no means aware of the fact, nor is the general practitioner, that a great deal can be done in the prolongation of life—two or three or four or five years—with a minimum amount of treatment, and of a type which does not annoy the patient.

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Sunlight and Vitamin D. A. v. Wijk, E. H. Reerink, and W. Mörikofer. *Strahlentherapie*, 1930, XXXIX, 80.

In previous investigations, the authors studied qualitatively the absorption spectrum of the products formed in irradiated ergosterol. They were able to determine the composition of an irradiated ergosterol solution from the absorption spectrum. The application of these results for a comparison of therapeutic lamps, suggested itself. It was necessary only to compare the amounts of Vitamin D produced in an ergosterol solution following exposure to various light sources. On that basis, the sun and a quartz mercury vapor lamp were

studied. As a measuring instrument between 2,900 Ångströms and 3,100 Ångströms, the authors chose a cadmium photo-electric cell. In the solution exposed to sunlight, the Vitamin D was destroyed much quicker, and a secondary decomposition product appeared. Although it is not possible to compare the effects of the two light sources, expressed in identical units of energy, the authors state that the ratio between vitamin destruction and vitamin production in an irradiated ergosterol solution was from 0.137 (for the quartz mercury vapor lamp) to 0.34 (for the sun).

ERNST A. POHLE, M.D., Ph.D.

# MALIGNANT TUMOR OF THE ETHMOID<sup>1</sup>

By J. E. HABBE, M.D., MILWAUKEE, WISCONSIN

**I**N a paper before the Radiological Society of North America at Toronto, December, 1929, on the treatment of malignant tumors of the nasal accessory sinuses, Douglas Quick, of the Memorial Hospital, New York City, said: "It has been our unfortunate experience that radiographs for diagnostic purposes have not been as valuable as one might ordinarily expect, except in the very late stages where the differentiation is obvious to other and simpler

help in 90 per cent of these cases of carcinoma involving the accessory sinuses."

The writer's personal experience in tumors involving the accessory sinuses has been too limited to warrant any statement as to the percentage of accuracy of the X-ray diagnosis of this condition. This single case is presented, however, as one in which the X-ray signs of malignancy were present some six or seven weeks prior to definite clinical findings.

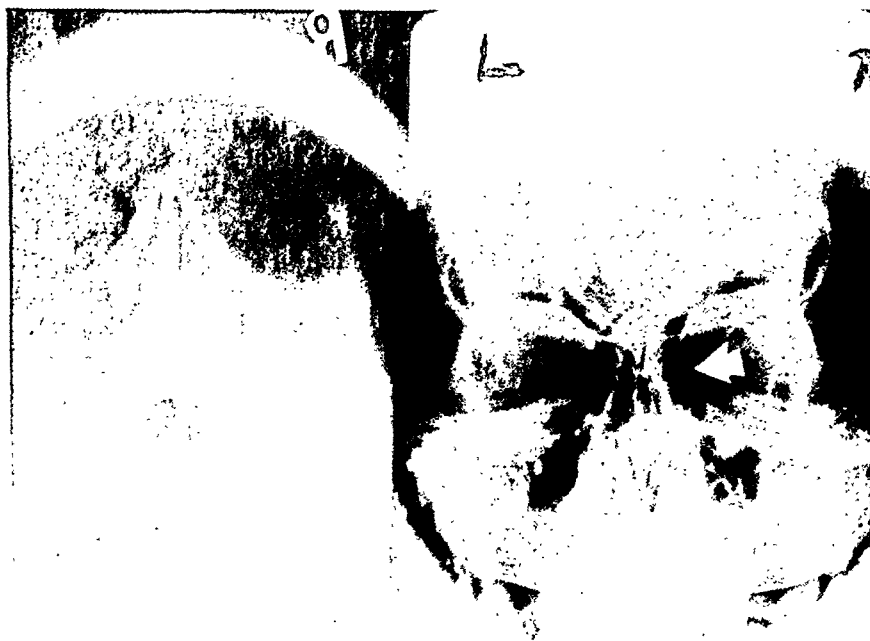


Fig. 1. Erosion of right lamina papyracea indicated by arrow. Seven weeks prior to possible clinical evidence of tumor.

means of examination. We feel that diagnostic X-rays have been of real value in only about 5 per cent of the cases."

In a discussion of this article, however, Pfahler said: "I believe that we should get

<sup>1</sup>Read at the mid-year meeting, Radiological Section, Wisconsin State Medical Society, May 23-24, 1930, Green Bay, Wisconsin.

## CASE REPORT

A man, aged 38, was referred for X-ray examination November 25, 1929, because of pain of recent origin in the right eye and temple. The patient also had some dullness in the head and a strained feeling in the

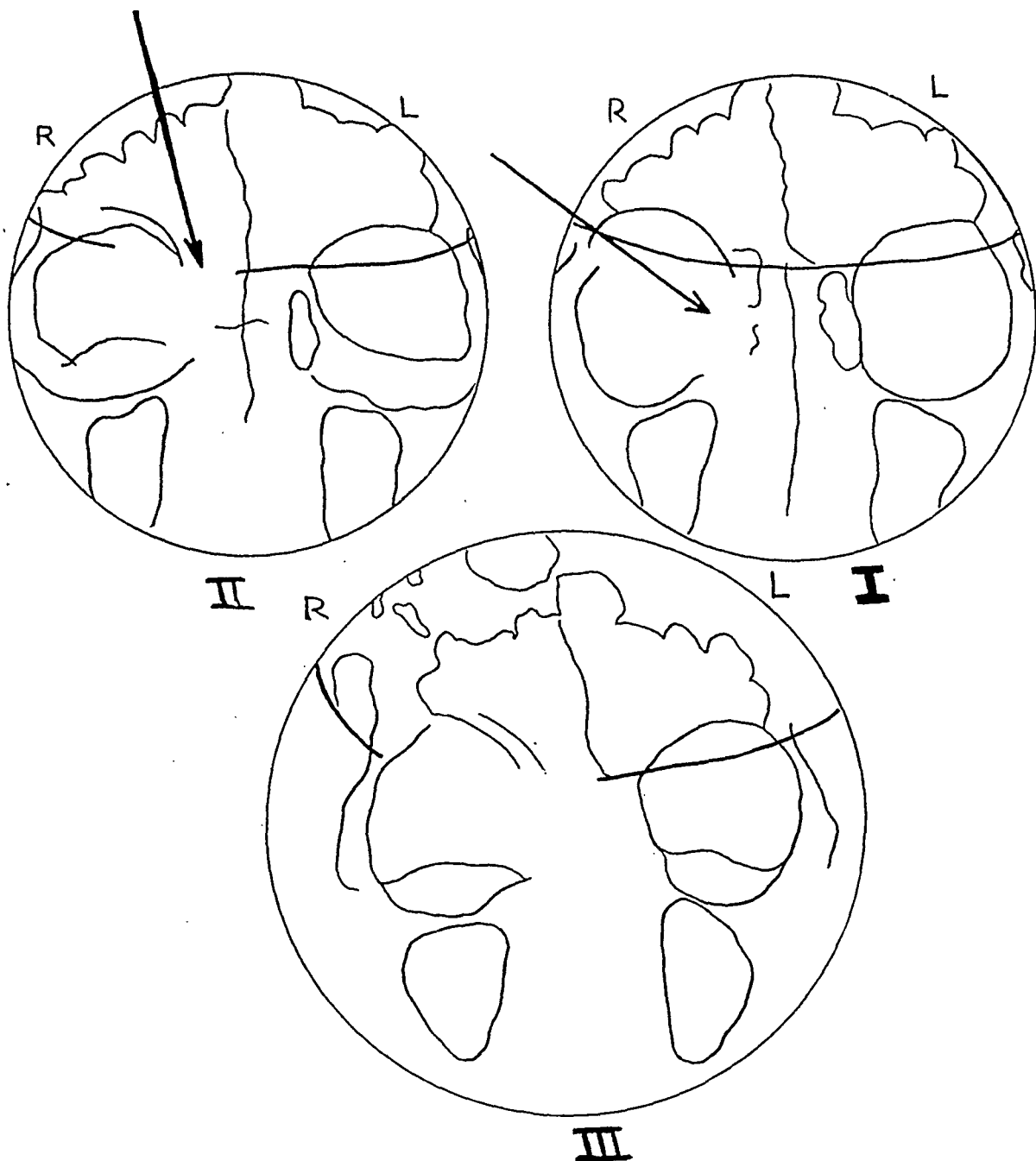


Fig. 2. Diagrammatic sketch showing (I) erosion of right lamina papyracea at first examination; (II) appearance seven weeks later, with additional destruction of right cribriform plate and portion of floor of anterior fossa; (III) final appearance following exploration and radium insertion into tumor-bearing area, one month prior to death.

eye, which symptoms were relieved by aspirin. A recent change in glasses had also given considerable relief. Rhinoscopy was

essentially negative, but transillumination of the right frontal sinus and right antrum showed slight haziness, and by ophthal-



## RADIOLOGY

not remarkable, there having been occasional colds, and change of glasses—as might be in the past history of anyone, at the given age and in this climate.

On the day of the first X-ray study the clinician stated that there seemed to be a slight increase in ocular tension of the right eye, but there was no nystagmus or double vision.

The essential X-ray findings at this time were a slight diffuse clouding over the right ethmoid region, with loss of much of the bony detail of the cell trabeculae and a portion of the medial orbital margin (that portion made up by lamina papyracea). The shadow was best shown on the Caldwell film, the evidence of the ethmoid pathology was confirmed by the Granger projection.

Fig. 3. Granger projection, showing marked right ethmoid clouding.

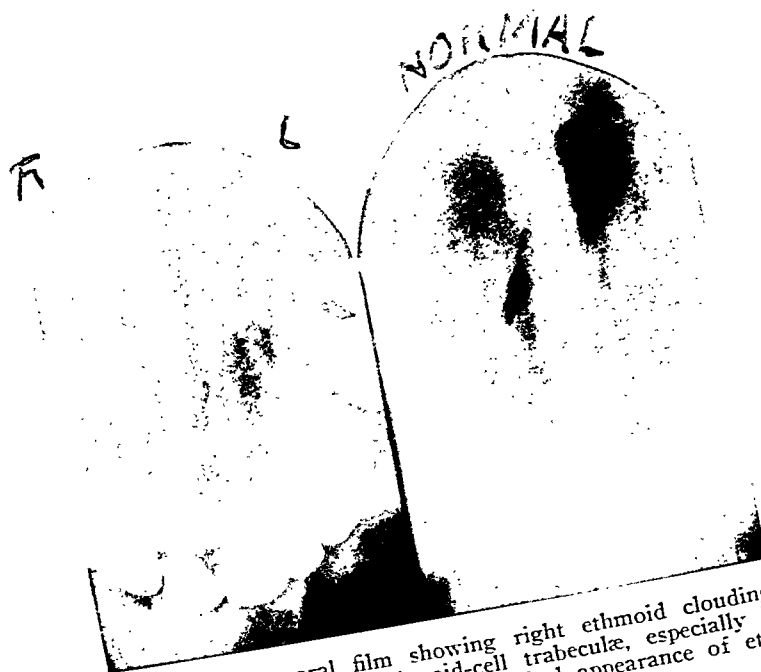


Fig. 4. Intra-oral film showing right ethmoid clouding, with disappearance of ethmoid-cell trabeculae, especially in posterior ethmoid region. (Symmetrical appearance of ethmoids on intra-oral film shown on right.)

moscopic examination the discs were slightly hyperemic but were equally so on both sides and the margins were quite clear.  
The past eye, ear, and nose history was

and the destruction of the ethmoid cell trabeculae was most clearly shown on an intra-oral film taken with a Hayden cassette. Each of these three views was of distinct value

in arriving at a diagnosis of malignant disease involving the right ethmoid region.

The patient was seen in consultation by other clinicians, but the X-ray impression could not be clinically confirmed.

of a therapeutic test, for the patient suffered a moderately severe reaction in the way of marked increase in pain and repeated vomiting for a period of two or three days thereafter.



Fig. 5. Showing additional destruction of right cribriform plate at time of development of positive clinical signs of malignant tumor.

The question of X-ray therapy came up, but, following the recommendation of Sosman that roentgenotherapy in any case of intracranial tumor must be given with caution and rarely administered before an attempt has been made to extirpate or at least do a decompression, the advice was against therapy. However, because of increasing headaches and eye pain, a small dose, using a portal one inch in diameter, over the right ethmoid region anteriorly, was given on December 7, 1929, employing the following factors: 130,000 peak volts, 40 ma.-min., 12-inch distance, filter of  $\frac{1}{4}$  mm. copper and 1 mm. aluminum (well under 25 per cent skin erythema in view of the small portal).

From the roentgenologic standpoint, the single X-ray treatment served as something

Within a few days of the treatment the patient had sufficiently improved from his reaction to warrant his travelling to another city, where he underwent a general study for some days, but again the original diagnosis of tumor could not be substantiated and treatment was outlined on the assumption that the patient's symptoms were in the nature of a sphenopalatine ganglion neuralgia.

He returned to his home and made some effort to resume his business but the pain and headache gradually increased and on January 13, 1930, when referred again for X-ray study (just seven weeks following the date of the original sinus X-rays), the clinician reported that the patient showed, for the first time, unilateral exophthalmos,

loss of central vision, and a bulging into the ethmoid region of the right nose. The X-ray findings at this examination were def-

found, and multiple areas of destruction in the right frontal bone were also shown, which were attributed entirely to tumor ex-

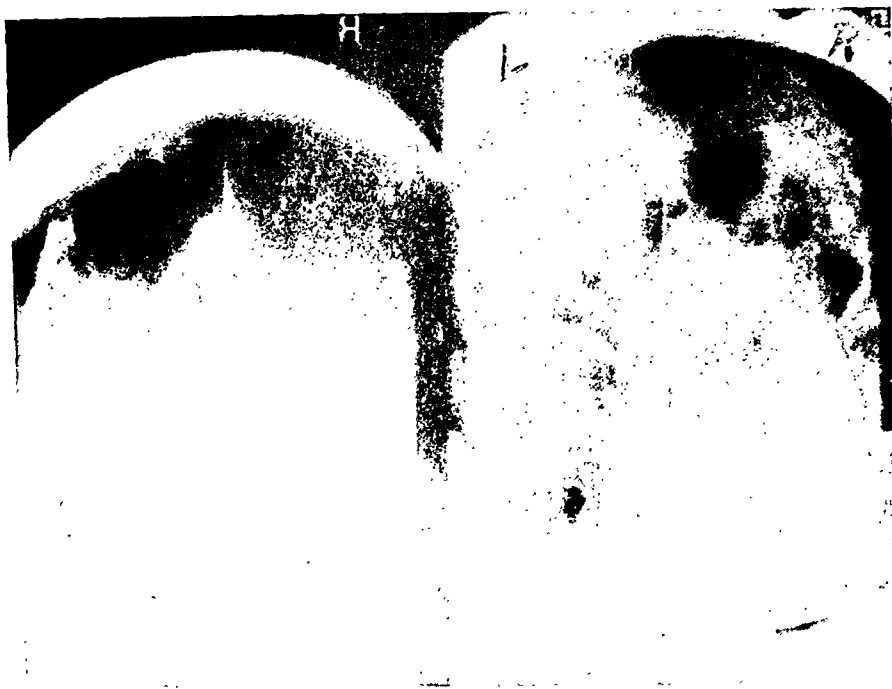


Fig. 6. Final examination following exploration and radium therapy. Death one month later.

inite increase in bone destruction as manifested by a disappearance of the line representing the right cribriform plate.

A radical trans-frontal exploration of the right ethmoid region was made and tumor involvement of the ethmoid labyrinth was found, the microscopic diagnosis being epithelioma graded three. The origin of the tumor could not be determined. Radium was inserted into the operative wound and left sufficiently long to give an intensive dose of filtered rays.

Again the patient returned to his home and again made some final effort to resume his business, but the pain became worse and the vision was lost in the affected eye.

Final X-ray studies were made on March 28, at which time even more extensive destruction of the right orbital margin was

tension, although undoubtedly the evidences of right frontal and maxillary sinusitis may have been in some part an evidence of radium reaction.

The patient died April 27, 1930, just five months after the first definite diagnosis of malignant tumor had been made.

#### CONCLUSION

A case of epithelioma involving the right ethmoid region is reported, in which definite X-ray evidence of an invasive lesion, with destruction of the ethmoid cell trabeculae and the lamina papyracea, was demonstrated some seven weeks prior to positive clinical signs of tumor. The tumor grew rapidly despite intensive radium irradiation from within it, and death ensued

within five months of the time the original diagnosis of tumor was made.

The author wishes to thank Dr. H. G. Martin and Dr. T. L. Tolan for kindly supplying the clinical findings, and Mr. Leo Massopust, Marquette Medical School artist, for the reproductions and diagrammatic sketches.

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The Relation between Division Rate and the Radiosensitivity of Cells. Charles Packard. *Jour. Cancer Research*, August, 1930, XIV, 359.

The author irradiated *Drosophila* eggs whose rate of cell division can be controlled by temperature. The eggs had been kept at the desired temperature for thirty minutes or more before radiating and during radiation. The temperatures employed were 13°, 23°, and 28° centigrade. The dose of X-rays in each instance was 150 K.V., 5 ma., at 40 cm. distance. Measurements showed that the intensity of the beam falling on the eggs was 17.0 r-min., including the scatter from the water and the walls of the chamber. The filtration was 0.25 mm. of copper and 1.0 mm. of aluminum. After 5, 10, 15, and 20 minutes of radiation, samples were removed and incubated in a moist chamber at room tempera-

ture. The percentage of eggs which hatched was considered an index of the effect. The author concluded that susceptibility rises as the rate of division at the time of exposure increased. The two curves, however, are not parallel.

*Drosophila* eggs were irradiated at room temperature and immediately afterward divided into two lots, one incubated at 18° and the other at 28° centigrade. The sensitivity of the chilled eggs was 89 per cent of that of the eggs reared at room temperature; the sensitivity of the warmed eggs was 110 per cent. This difference exceeds by far the limits of ordinary variation.

The author concluded that the activity of cells after exposure is also a factor in determining the ultimate injury sustained. The effect is lessened when the activity is decreased.

JOHN R. CARTY, M.D.

# CASE REPORTS AND NEW DEVICES

## HEAD CLAMPS FOR A FENESTRATED SHIELD FOR ROENTGENOGRAPHY OF THE NASAL ACCESSORY SINUSES

By MRS. J. D. BLOCHER

Section on Roentgenology, The Mayo Clinic  
ROCHESTER, MINNESOTA

An improvement has been made on the fenestrated shield described in *RADIOLOGY*, February, 1928, X, 163. The shield presented here consists of a lead plate 1.15 mm. thick, faced on each side with a sheet of brass 0.4 mm. thick, making a composite plate with a total thickness of 1.95 millimeters. The mask is large enough to cover an 8 by 10 cassette exactly, and has a flanged edge to prevent any displacement. Two disks have been cut out of the mask, leaving two circular apertures, spaced 12 cm. center to center. These disks fit the openings in the mask exactly, one being kept

in place while an exposure is being made through the opposite side. Each disk has a rivet soldered in the center to facilitate handling.

The improvement comprises two metal wings adjustable on a common sleeve, which, in turn, is mortised and movable on a square bar. The ends of the square bar are secured in the upper ends of two brackets permanently fastened to the shield. The metal wings extend 15.2 cm. from their supporting hubs, broadening from a width of 3.17 cm. at the hub to 6.03 cm. at the outer ends. They are 1.58 cm. thick, with edges and corners rounded. The hubs are fitted to slide easily for adjustment over the sleeve and are anchored in position by thumb screws.

The cylindrical shape of the sleeve permits the wings to be moved vertically and fastened in position as desired. The sleeve slides easily for lateral adjustment and is held in position by a thumb screw fitted into

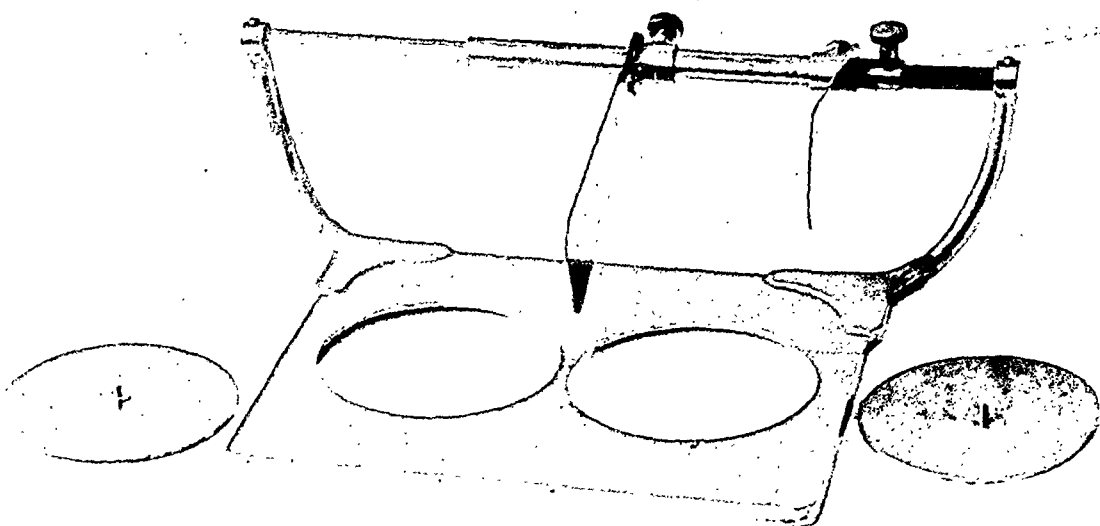


Fig. 1. The mask, with disks and head clamp.

one end. The fact that the square bar is stationary and is permanently secured to the two brackets, permits the sleeve and wings to be easily located and fastened in proper position. The brackets extend at  $45^\circ$  outward 6.98 cm. from, and 8.89 cm. above,

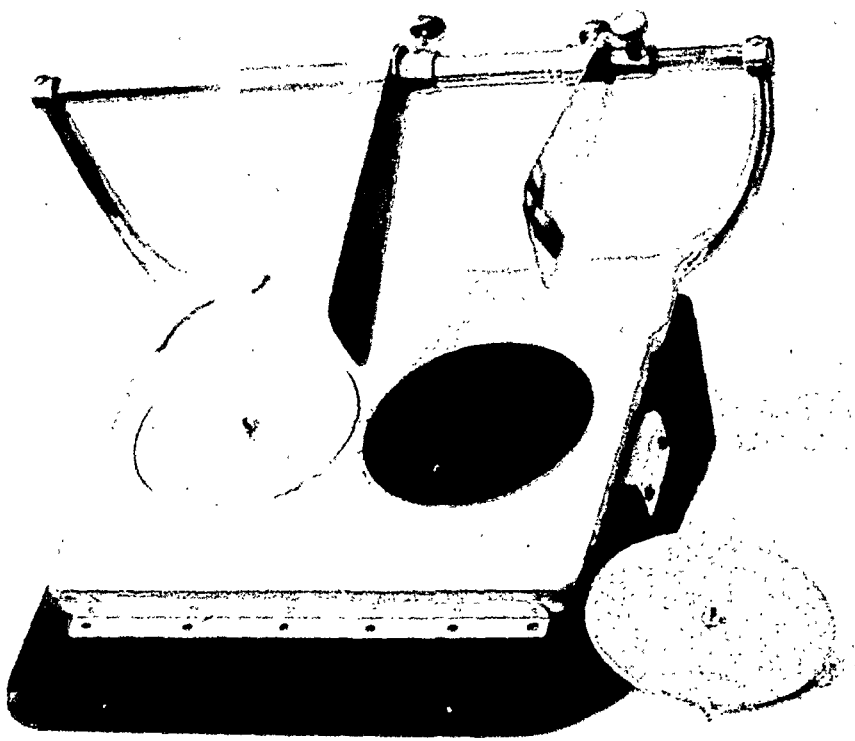


Fig. 2. The cassette, covered with the mask, placed on sinus board.

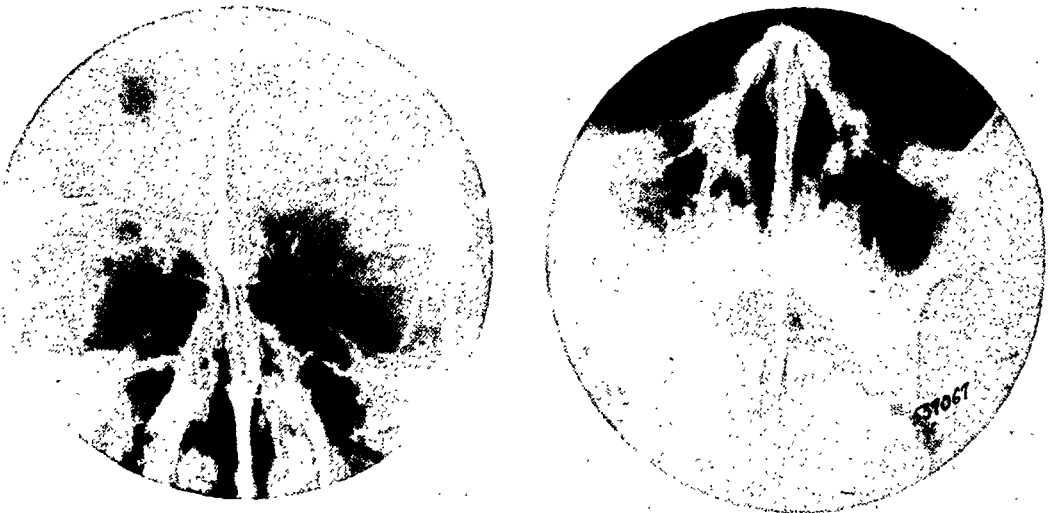


Fig. 3. Exposures made by the use of the mask; the nasal sinuses.

the top of the shield and are 38.1 cm. apart. The sleeve is of 1.74 cm. outside diameter and is 22.86 cm. long. The wing hubs are

mortise to receive the ends of the bar which are held by a No. 8-32 machine screw in each.

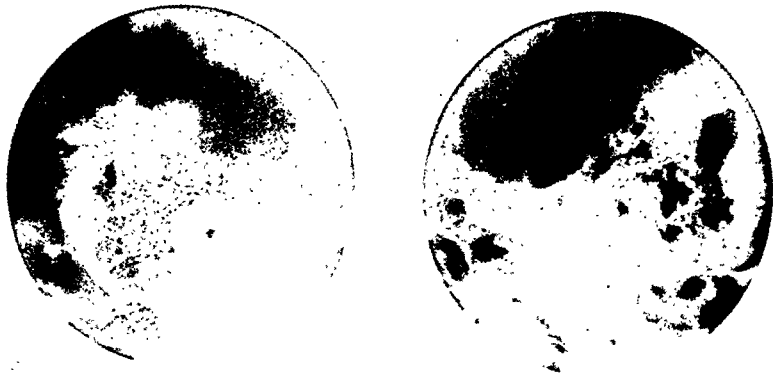


Fig. 4. Exposures made by the use of the mask; the mastoid regions.

2.54 cm. long and 2.22 cm. in diameter. The bar is 0.952 cm. square in cross-section and 40.64 cm. long. The upper ends of the brackets are 1.40 cm. in diameter and 1.27 cm. long, each having a 0.952 cm. square

Although this instrument was devised previously for roentgenography of the nasal sinuses, it has been found of equal utility in the making of roentgenograms of the mastoid regions.

## REPORT OF A PATIENT WITH EWING'S SARCOMA<sup>1</sup>

By E. ERIC LARSON, M.D.,  
LOS ANGELES, CALIFORNIA

The patient, Mrs. H. B. P., aged 23, employed as a cashier, married six months, was seen Oct. 17, 1930. Her complaint was that of constant boring pain in the upper part of the left femur, with marked swelling, and progressive loss of weight.

She stated that eleven weeks previous to this initial examination, after a game of tennis, she felt that a lumbar vertebra was out of place. This was adjusted by an osteopath who, at the third and last treatment, gave her legs a vicious jerk. Two days later

the patient noted pain in the upper portion of the femur, with a noticeable swelling anteriorly. Her physician found a slight fever, but could not ascertain the cause of her trouble. After the patient had taken medicine for a time the pain disappeared, but the swelling progressed. Two months later, after a horseback ride, the pain recurred and persisted. At this time the blood count was normal. X-ray examination of the left femur and thigh was reported negative. The patient spent three weeks in bed, complaining of pain, tenderness, and progressive enlargement of the tumor, with slight fever; then she consulted us for an opinion as to the cause of her distress and suggestions for relief.

Physical examination revealed a slender young woman, weighing ninety-five pounds,

<sup>1</sup>Presented before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 5, 1930.



Fig. 1. X-ray film taken Nov. 5, 1930, shows suspicious defect in the upper portion of the femur. In the soft tissues around this defect can be seen a shadow of the tumor.



Fig. 2. X-ray film taken Nov. 19, 1930, definitely reveals the defect in the upper portion of the femur. It has also increased in size and has the appearance of an osteomyelitis.

who said that she had had a loss of fifteen pounds during the past eleven weeks. She was pale and looked ill. The left thigh was quite swollen, with no apparent demarcation of the tumor. The mass appeared to be semi-solid in consistency, with a generalized tenderness over the whole area of swelling.

Blood analysis revealed 4,400,000 erythrocytes and hemoglobin of 12.5 gms. (72.6 Sahli); 9,100 leukocytes differentiated as neutrophils 53 per cent; eosinophils 1 per cent; large lymphocytes 44 per cent; mononuclears 1 per cent. The coagulation time was four minutes. The blood Wassermann was negative.

X-ray examination of the left femur revealed a very slightly suggestive lesion in its upper third. No definite diagnosis could be made from the X-ray studies (Fig. 1).

A diagnosis of hematoma, osteomyelitis, or sarcoma was made and exploration ad-

vised. Accordingly, on Oct. 21, 1930, the anterior aspect of the thigh was opened, just over Scarpa's triangle. By blunt dissection down to the periosteum there was encountered near the bone what appeared to be an organizing blood clot about 5 cm. in diameter. This was carefully swabbed out and, since no other mass could be felt and the periosteum seemed intact, we were of the opinion that we were dealing with a hematoma. The wound was closed, a rubber drain inserted which was removed on the fourth day, followed by prompt healing. The blood clot was cultured and also examined under the microscope, and was reported negative.

On Nov. 20, 1930, because of increased swelling and pain, it was found necessary again to explore the thigh. The X-ray examination showed that the original defect in the femur had become larger in extent and



the top of the shield and are 38.1 cm. apart. The sleeve is of 1.74 cm. outside diameter and is 22.86 cm. long. The wing hubs are

mortise to receive the ends of the bar which are held by a No. 8-32 machine screw in each.

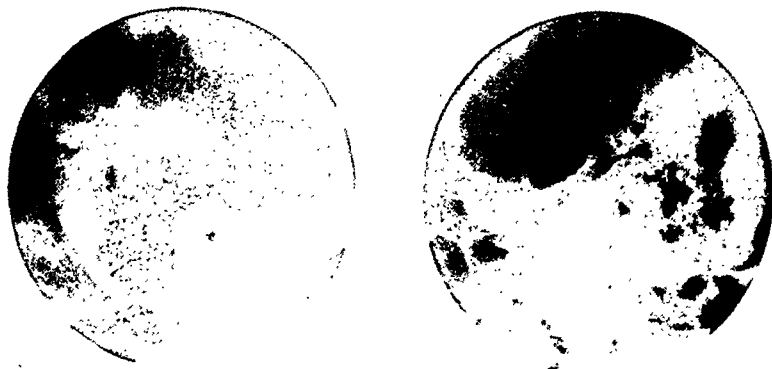


Fig. 4. Exposures made by the use of the mask; the mastoid regions.

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the diagram, Figure 1, shows, it consists essentially of a gang switch of special design, bolted inside the control cabinet of the

just as if the switch were not there. When the switch is pulled to the left, No. 2 is disconnected from No. 3 and connected to No.

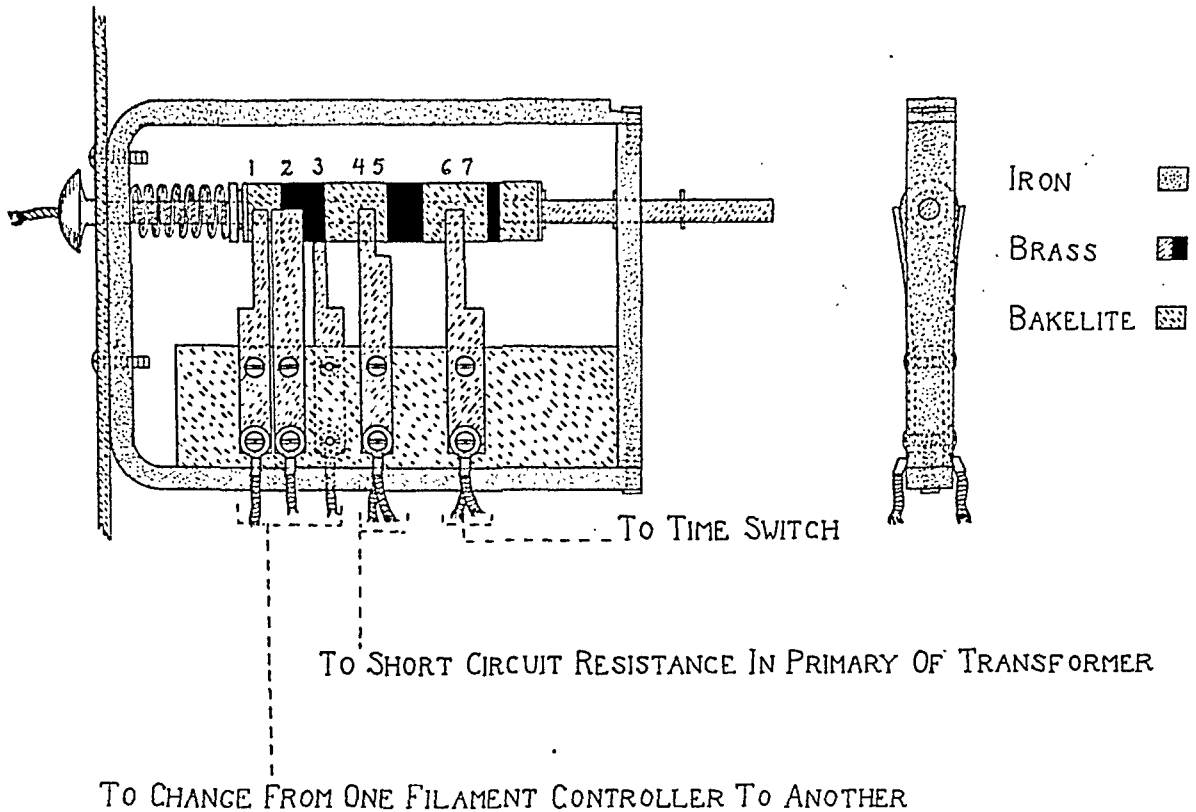


Fig. 1. Drawing of the switch in the fluoroscopic position. The instrument is mounted inside the control cabinet of the X-ray machine and the knob on the left extends through the side of the cabinet. It is operated by a pull on the cord, and is returned to the fluoroscopic position after the pull is released, by the coil spring.

X-ray machine, and is operated by a pull cord fastened to the handle which projects through the side of the cabinet. The three brass rings are all mounted on a bakelite rod and insulated from each other and from the central shaft. Spring brass brushes are so arranged that they make contact with the rings when the switch is pulled into active position.

The diagram shows the switch in the fluoroscopic position where Brush No. 2 is connected electrically with No. 3, these two being connected in series with the filament controller on the X-ray machine. This allows the current to flow to the controller

1, cutting in another filament controller which has been set up to the desired milliamperage. Thus the problem of milliamperage is met. A wire-wound rheostat answers the purpose well for this extra controller.

Brushes No. 4 and No. 5 are connected together electrically when the switch moves to the left and short the resistance in the primary of the transformer. This has the effect of changing from the "Limited" to the "Full" capacity on the KK disc rectifier machine. On a machine of other make it would be used to short that part of the resistance which was used for fluoroscopy.

Brushes No. 6 and No. 7, when closed, set up the time switch. While this instrument is intended to be used in conjunction

It is to be noted that while the brushes for the timer and filament controller are small, the ones that short the resistance

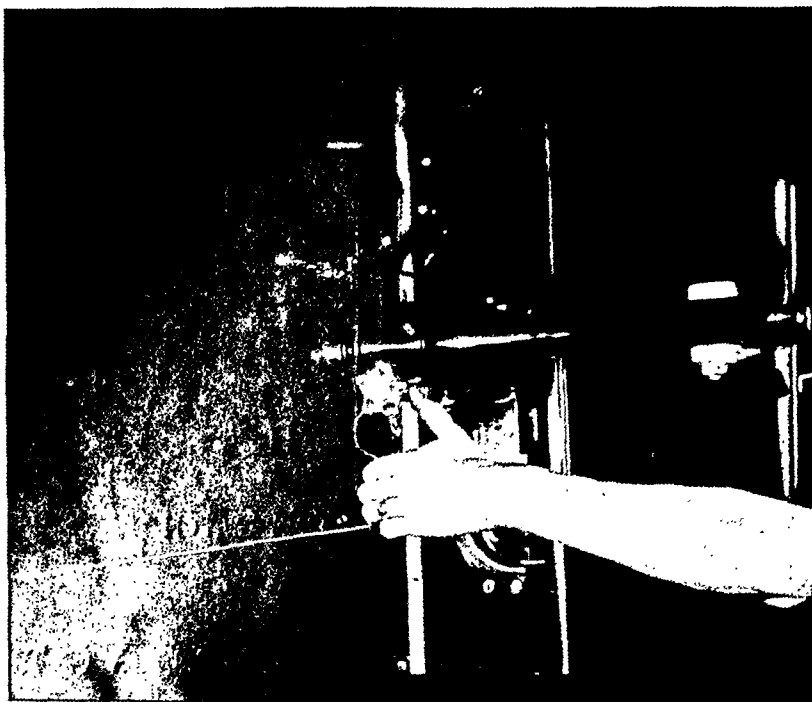


Fig. 2. Showing how the pull cord is used by the left hand of the operator, as he stands at the fluoroscope.

with the author's timer (1), it could be made to set up any one of the motor-driven timers by turning on the current to the motor.

The exposure is made with the foot switch while the operator holds the cord in his left hand, as shown in Figure 2.

should be large enough to carry about 50 amperes.

This instrument has been in steady use for over four years, needing no attention except an occasional drop of oil.

#### REFERENCE

TAFT, ROBERT B.: Time Switch of Unusual Design.  
RADIOLOGY, November, 1930, XV, 592.

# EDITORIAL

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M. J. HUBENY, M.D. . . . . *Editor*  
BENJAMIN H. ORNDORFF, M.D. . . . *Associate Editor*

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## THE RÔLE OF RADIOGRAPHY IN MATERNITY CARE

A distinctly modern phase of obstetric practice is the comprehensive care of the mother during pregnancy and after labor has been accomplished, especially the former. Obstetrics, it is being realized more and more, comprises much more than the mere delivery of the child. The prophylaxis of disease and of abnormal presentational complications has become a very important part of the duties of the obstetrician; and this prenatal care of pregnant women is now insisted upon in private practice as well as in the prenatal clinics for the poorer classes of women that have sprung up all over the country.

Our attention has been called recently to this subject by the illuminating report of the Maternity Center Association and the Statistical Bureau of the Metropolitan Life Insurance Company, of New York. The records presented by these organizations cover 4,726 women who were cared for during the eight years, 1922-1929, inclusive. Very striking results were obtained by this prenatal management, including a reduction of the maternal mortality to about a third of that obtaining among women not receiving the prenatal attention; a reduction of infant deaths in the first month of life of 32 per cent, as compared with the control group in

the same metropolitan area, and a record of stillbirths 42 per cent lower than that occurring among women not receiving prenatal care.

No woman under this care died before delivery during the entire eight years; and only 11 mothers died from puerperal causes, a rate equivalent to but one puerperal death for every 430 pregnancies. The maternal mortality rate based on live births was 2.2 per 1,000, which compares favorably with the rate of 5.3 per 1,000 live births among white women in New York City. In the Bellevue-Yorkville district the mothers who did not have the care of the Maternity Center Association showed a maternal mortality rate of 6.2, or nearly three times as high as the rate for mothers who had that care.

Such results are very convincing, and amply emphasize the value of the care given the women.

It would be interesting to know just what part in this reduction of fetal and maternal morbidity and mortality was played by radiography of the pregnant women. No data are given on this subject in the records published by the investigating bodies. The very short period of exposure required to make roentgenograms of the pelvis and abdomen renders this valuable diagnostic aid absolutely safe; and when one recalls how much information of value may be obtained from these X-ray films, it becomes evident that radiography should hold a prominent place in the prenatal care of pregnant women.

Not only can deformities and contractures of the maternal pelvis be recognized early and appropriate treatment instituted, such as the induction of premature labor or an elective cesarean section, with or without

the test of labor, but fetal abnormalities of development and abnormal positions and presentations may also be noted early and the latter corrected in many instances. We firmly believe that every pregnant woman should be examined by the X-ray at intervals from the fifth month on, as a valuable aid to the obstetrician in noting the progress of the case. The fear that uterine or fetal death or deformity may be so produced may be discarded, for these accidents can occur only from prolonged irradiation in the very early weeks of gestation during the formative period of the embryo.

We believe that all that is necessary is to call the attention of these public welfare bodies to the value of a proposed innovation. Sufficient proof is now available to show that the judicious use of the X-ray in the diagnostic study of pregnancy has been productive of much good, and we can positively conclude that, consequently, the X-ray has become an important prophylactic measure and aid in obstetric diagnosis.

W. A. NEWMAN DORLAND, M.D.

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#### REPORT OF CHAIRMAN OF COMMITTEE ON INSURANCE

*To the officers and members of the Radiological Society of North America, Sixteenth Annual Meeting, at Los Angeles, 1930:*

Your Committee on Insurance begs leave to present the following report:

During the past year several members of the Society have asked the Chairman what was known about certain insuring organizations and agencies, and, because of these inquiries, he has taken upon himself as a duty the investigation of some of these insurers, particularly those not well known to us.

After investigating one of these organizations which offers a rather attractive low

premium rate, he secured the following information.

The — Company, of —, was incorporated several years ago, after certain of the regular malpractice insurance companies notified users of the Abrams Electronic Reactions methods that they must either discontinue using the "ERA" or have their malpractice insurance contract canceled. The — Company in question was organized on the mutual plan, a plan decried by men who know the malpractice insurance business and one which, it has been decided by courts of last resort, will render a member of such organization incompetent as a witness for and in a malpractice suit against any other member of the same organization (Hoover vs. McCormick, Kentucky case). The original board of directors of this Company consisted of three physicians, all "ERA" users, and two osteopaths. In about a year one of the physicians was displaced by an osteopath, whereupon the governing body was composed of three osteopaths and two physicians, and neither of these two latter were members of organized medicine. The Company's literature at that time stated that its organization was by, of, and for electronists, and a little later it made the same statement in regards to being by, of, and for osteopaths.

An abstract from a letter written by one of the officers of this insurance organization about three years ago reads in part: "You will be surprised to know how fast our company is becoming osteopathic in its membership." At that time one of the principal officers of that State's Osteopathic Association was on the directorate of this Company.

The insurance contract issued by this Company has contained several items to which serious exception can and should be taken, and with which serious fault can be found, but as these documents change from time to time some of these objections may have been eliminated.

Although the organization investigated

has been in business considerably over seven years, a recent financial report indicated that its assets amounted to less than \$12,000, and the latest financial report shows its assets as less than \$13,000.

Your Committee also desires to call the attention of members of the Radiological Society to a report of the "Bureau of Investigations" of the American Medical Association, published in the *Journal of the American Medical Association* for December 20, 1930, page 1931, and to suggest that all should read the last paragraph at *least three times*, and then refer to what your Committee on Insurance has repeatedly stated in regard to *mutual insurance companies*.

The Chairman of your Committee on Insurance receives from two to six letters every month relative to malpractice insurance, and answers from two to twenty questions regarding insurance in each letter. He has in preparation a paper covering the subject of malpractice insurance in a thorough manner, which it is hoped will be ready for publication some time within the next three or four months.

In conclusion, the Chairman desires to recommend that this Committee be continued and that this report be published in RADIOLOGY.

I. S. TROSTLER, M.D., *Chairman*.

A motion was made, seconded, and unanimously carried that the report be received and the recommendations concurred in.

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## HONORS IN OTHER SOCIETIES

Ulysses S. Kann, M.D., a member of the Society from Binghamton, New York, has been honored with the presidency of the Broome County (New York) Medical Society. Blinn A. Buell, M.D., is Vice-president, Henry D. Watson, M.D., is Secretary, and Charles Pope, M.D., is Treasurer.

Dr. Kann was likewise elected to the presidency of the Central New York Roentgen Ray Society, at the January meeting in Syracuse. Lucas S. Henry, M.D., a member of the Radiological Society of North America from Syracuse, was elected Vice-president, and Robert C. Hall, M.D., a member from Utica, was chosen Secretary and Treasurer of the Central New York Roentgen Ray Society.

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## CANADIAN RADIOLOGISTS FOSTER EDUCATIONAL PROPAGANDA

At the recent joint meeting of the British and Canadian Medical Associations in Winnipeg the Radiological Section of the Canadian Medical Association decided to publish in the *Canadian Medical Association Journal* a series of papers the purpose of which is to present to the general profession an authoritative statement concerning the ever-enlarging field of X-ray and physiotherapy. In a Foreword in the January number of the *Canadian Medical Association Journal* the Editors refer to this program in the following statement: "We intend to publish a series of papers, designed for the general practitioner and the man working in the small hospital, dealing with the theory and practical applications of radiology and physiotherapy in their various aspects. These papers will be written by men expert in these particular fields and will be submitted for comment to specialists and others, in the hope that all sides of the subjects will be fully canvassed."

Dr. E. E. Shepley, of Saskatoon, Saskatchewan, has been appointed by the Radiological Section of the Canadian Medical Association to have general charge of this ambitious program, and he already has a large number of papers contributed and on

the way. We bespeak for Dr. Shepley the hearty co-operation of our American confrères when he appeals for help in carrying out this educational work.

L. J. CARTER, M.D.

on Radiology. All coming *via* Chicago may secure reservations by writing me. It is more pleasant to travel together.

I. S. TROSTLER, M.D.  
812 Marshall Field Annex, Chicago.

## MINNESOTA RADIOLOGICAL SOCIETY

The midwinter meeting of the Minnesota Radiological Society was held February 14, 1931, at the Minnesota Club, St. Paul, Minnesota. The following program was presented:

Roundtable Discussion of Cases of Diseases of the Bones and of the Thorax. Conducted by R. G. ALLISON, M.D., Minneapolis.

Roundtable Discussion of Cases of Diseases of the Gall Bladder and of the Gastro-intestinal Tract. Conducted by JOHN D. CAMP, M.D., Rochester.

Roentgenologic Changes Seen in Cases of Boeck's Sarcoid and Related Lesions. S. A. MORTON, M.D., Rochester.

A Correlation of the Various Factors Involved in the Classification of Chronic Arthritis. M. J. SHAPIRO, M.D., Minneapolis.

Pulmonary Metastases. EUGENE T. LEDDY, M.D., Rochester.

The Medical Histories of Cases of Carcinoma of the Stomach. JACOB SAGEL, M.D., Minneapolis.

## GOING TO PHILADELPHIA?

The American Medical Association holds its 1931 Session there June 8 to 12, inclusive.

The Pennsylvania Lines have furnished me with a diagram of a sleeping car on the train leaving Chicago at 12:30 p. m. and arriving at Philadelphia at 7:43 a. m. the morning of the first meeting of the Section

## BOOK REVIEW

THE ORIGIN OF LYMPHOSARCOMATOSIS AND ITS RELATION TO OTHER FORMS OF LEUKOSIS IN WHITE MICE. BY CARL KREBS, H. C. RASK-NIELSEN, and AAGE WAGNER. *Acta Radiologica*, Supplement X, Stockholm, 1930. pp. 53. with 15 plates.

This report of experiments and observations on 16,900 white mice is most interesting in that it appears to show that, in such animals, lymphosarcoma is the result of lowered resistance, and that such depression of resistance may be brought about by exposure to roentgen rays. Unfortunately, as an experimental report this communication cannot be regarded as a model. So many essential details have been omitted that, while the main results must be accepted as proved, many subsidiary points remain obscure, and the interpretations advanced cannot be analyzed satisfactorily. The doses given are not accurately described. In one place it is stated that to obtain "takes" in about 50 per cent of the animals the entire body of the animal had to be exposed to about 75 per cent of a lethal dose (minimum dose that will kill a mouse weighing from 15 to 20 grams within two weeks), and this was regarded as equal to about four-fifths of the human erythema dose through 5 mm. of aluminium. The quantity and quality of the rays are not specified. But when the dose was reduced to one-half the human erythema dose (about 60 per cent of the lethal dose), the percentage of "takes" di-

minished greatly. Further on the statement is made that "the smallest local irradiation given was of two erythema doses, applied in a single exposure on barely one-third of the animal's body at the hindmost part. Most of the doses were somewhat larger, however." That exposure of part or of the entire body of animals to roentgen rays should act to lower resistance to transplanted tumors is not surprising. However, these experiments do not furnish any clue to the factor or factors involved in such depression of resistance. Moreover, the possibility that such depression may have been partly due to factors other than irradiation has not been excluded.

Krebs, Rask-Nielsen, and Wagner never found bacteria in any of the tumors, thus confirming the work of Korteweg. Aside from the effect of roentgen irradiation in decreasing resistance and thus increasing the transplantability of lymphosarcoma, the most interesting results were that the majority of such transplanted tumors disappeared spontaneously, that it was possible to keep two strains alive for many generations, and that irradiation apparently facilitated

the spontaneous occurrence of leukemic changes.

But perhaps the most interesting part of the report is the description of the lymphosarcomatous lesions found at necropsy. While such lesions may differ slightly from those occurring in human beings, one experienced in human lymphosarcoma must be impressed by the surprising analogy. Another noteworthy point is the tendency of the blood of affected animals to exhibit leukemic changes. As the total number of leukocytes increased the percentage of polymorphonuclear cells diminished and the percentage of lymphoblasts increased.

In attempting to explain why, in view of the atrophy of the lymphoid structures previously shown by Heineke, Ziegler, Fabricius-Moeller, Murphy, Morton, and others, exposure of their animals to roentgen rays should have given rise to leukemioid changes, Krebs, Rask-Nielsen, and Wagner favor the correlation theories of Ziegler and Naegeli, but they are not able to prove such a relationship and admit that similar disturbances may be produced by other means than roentgen rays.

A. U. DESJARDINS, M.D.

## ABSTRACTS OF CURRENT LITERATURE

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## APPARATUS

**A New Model Radium Emanation Plant.** Alexander J. Allen. *Jour. Cancer Research*, August, 1930, XIV, 461.

The author describes a new model emanation plant in which a two-stage mercury diffusion pump is used in connection with a Megavac oil pump. The parts subject to strain are made of heavy pyrex glass. He feels that the apparatus is efficient, compact, and relatively inexpensive. The use of pyrex glass makes for ruggedness of construction.

JOHN R. CARTY, M.D.

**Roentgen-ray Tubes, with Complete High Tension Protection up to 200 K.V.** A. Bouwers. *Strahlentherapie*, 1930, XXXVIII, 157.

The author, who has developed the Metalix tube, describes an equipment which is shock-proof up to 200 K.V. and 8 milliamperes. A number of illustrations demonstrate the construction.

ERNST A. POHLE, M.D., Ph.D.

**Nitrogen Peroxide from the Mechanical Rectifiers of a Deep X-ray Therapy Plant.** Rollo K. Newman. *Med. Jour. Australia*, May 3, 1930, I, 581.

In a room of cubic capacity, 36,790 liters (1,300 cubic feet), the total volume of nitrogen peroxide produced by running an X-ray machine at 200 K.V. and 30 ma. for 100 minutes was 2.13 liters, as measured by absorption in sodium hydrate.

The machine was of the two-unit type, employing the familiar and efficient rotating toroid system and spherical collectors.

J. G. STEPHENS, M.D.

**The Half Value Layer Meter of Christen in a New Form.** H. Th. Schreus. *Strahlentherapie*, 1930, XXXVII, 193.

For practical purposes, a simple and inexpensive instrument to determine the quality factor in therapy is badly needed. The author has made an attempt at improving the half

value layer measuring apparatus of Christen, and hopes that the manufacturers will soon offer a suitable model to the roentgenologist.

ERNST A. POHLE, M.D., Ph.D.

**A Superficial Therapy Apparatus with Constant Output.** W. Hondius Boldingh. *Strahlentherapie*, 1930, XXXVIII, 165.

A movable apparatus is described, designed especially for skin therapy. It operates at 45 K.V. and has a stabilizer which maintains the transformer potential constant within 3 per cent. A time switch permits one to set the exposure time for various technics in r-units. Because of the constancy of the output, recalibration, according to the author, is necessary only at long intervals.

ERNST A. POHLE, M.D., Ph.D.

**A New Measuring Device for Very Small Light Intensities.** B. Rajewsky. *Strahlentherapie*, 1930, XXXIX, 194.

A good photo-electric cell measures light energies as low as  $10^{-7}$  erg per square centimeter per second. The author describes, in this article, an instrument designed similar to the counter of Geiger and Müller, for small intensities of roentgen rays, beta and gamma rays of radiation. By using an amplification system, the counting of the galvanometer deflections can be recorded automatically or over a loud speaker. Thus, the sensitivity is increased about 20,000 times over that of the photo-electric cell. For counts of twenty minutes, the error amounts to approximately plus or minus 2 per cent.

ERNST A. POHLE, M.D., Ph.D.

**The Effect of Intensifying Screens in Relation to the Quality of the Radiations in Radiologic Technic.** Vittorio Podestà. *Rivista di Radiologia e Fisica Medica*, May, 1930, II, 336.

The author describes an experimental apparatus he has constructed to study photographic screens, with results as follows: The luminosity of the screen increases not only with the intensity of the rays but also with an

increase of the hardness of the rays (decrease of wave length), the latter because of the combination of effect in the film and intensifying screen. With an increase of voltage up to 85 kilovolts the increase of effect is regular, then it rises suddenly and evens off at about 120 kilovolts. Between these two voltages the maximum increase of photographic effect is obtained.

E. T. LEDDY, M.D.

A Practical X-ray Serialograph. A. I. Arneson. *Am. Jour. Surg.*, June, 1930, VIII, 1243.

The author has constructed a tunnel  $20 \times 24$  inches which will allow six separate exposures on one  $10 \times 12$  film, each one  $4 \times 5$  inches in size. This tunnel is suspended on an overhead trolley which runs on a one-inch gas pipe suspended from the ceiling. It is counterbalanced by an appropriate weight which runs in one of the nickel-plated standards of an old X-ray tube stand.

The advantages of this apparatus are that it can be pushed out of the way of the fluoroscope and yet is instantly available. It is easy by this method to make films of the duodenal cap in the upright position.

HOWARD P. DOUB, M.D.

The Calibration of Grenz-ray Tubes. O. Gfrörer. *Strahlentherapie*, 1930, XXXVI, 786.

The author has carried out a considerable number of measurements on low voltage apparatus and tubes with the Lindemann window. He concludes that fluctuations in the primary line are of much more influence to the emission of X-rays of long wave length than in the ordinary roentgen apparatus. For their elimination, it is necessary either to have automatic potential regulation or to check the output of the tube during the entire treatment. The voltmeter in the primary circuit does not give accurate readings of the secondary potential. All apparatus for use on low voltage tubes should be calibrated uniformly as to the

tube potential. Numerous tables and curves illustrate the results of his investigations in detail.

ERNST A. POHLE, M.D., Ph.D.

## APPENDIX (DIAGNOSIS)

The Roentgen Diagnosis of Chronic Appendicitis. Henry J. Walton and Samuel Weinstein. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 631.

In a routine study of 1,000 consecutive gastro-intestinal examinations, there was roentgen evidence of a pathological appendix in 152 instances, or 15.2 per cent. In the series presented the diagnoses were based on: (1) direct findings; (2) indirect findings. Of the direct evidences, the visualized appendix, which empties slowly and is persistently tender to palpation, is the most common. Of the indirect evidences, the ileal and colonic stases are the most common. The diagnosis was confirmed either clinically or at operation in 133 cases, or 87.5 per cent. The incidence of appendicitis was noted to be greatest between the ages of 20 and 50 years.

The authors include a tabulation showing the incidence of the various types of gastro-intestinal pathology, one showing the distribution of the ages in the various groups as well as sex, while another shows the percentage of agreement between the roentgen and clinical findings.

J. E. HABBE, M.D.

Roentgenologic Observations of the Appendix. Werner Knothe. *Röntgenpraxis*, Dec. 1, 1930, II, 1057.

The value of a roentgenologic examination for the diagnosis of diseases of the appendix is still debated. The filling or non-filling of the appendix after a barium meal has been used as a diagnostic sign. The author uses a barium enema and finds that he can, by this method, demonstrate the appendix as often as when the barium meal is used. A normal appendix is usually demonstrable, and only very few roentgenologists believe, at the present time, that visualization of the appen-

dix indicates pathology. Peristaltic waves can be observed occasionally, and a sphincter-like contraction at the base may often be seen. Failure of roentgenologic demonstration in combination with localized tenderness indicates a pathological process. Several cases, with reproductions of films, illustrate the author's method.

H. W. HEFKE, M.D.

**The Pathological Appendix.** Albert F. R. Andresen. *Med. Jour. and Record*, Aug. 20, 1930, CXXXII, 178.

What is meant by the term "pathological appendix" as returned by the roentgenologist, and what shall be done for a patient with such a diagnosis? Such a conclusion from X-ray evidence is based on a definite group of findings, including filling of the appendix with barium, failure to expel this in normal manner, with deformity and abnormal functioning of cecum, sometimes with reflex pylorospasm. Such findings indicate a condition usually known as "chronic appendicitis," which is itself usually a part of a general gastro-intestinal infection. Operation is indicated only in cases showing persistent symptoms due to complications. Eradication of all infective foci, of which the appendix may be one, with proper hygienic and dietetic care both pre-operative and post-operative, is essential.

W. W. WATKINS, M.D.

**The Roentgen Symptoms of Post-appendicitic Abscesses.** Rudolf Pohl. *Fort-schr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 19.

Fluoroscopic and radiographic observations during and after opaque clysma, eventually aided by air insufflation, and also following expulsion is the technic described by the author. Careful roentgen exploration never aggravates. In cases offering diagnostic difficulties valuable information may be obtained, though a definite diagnosis usually may be made only by correlation of all anamnestic clinical and roentgenologic data.

The following classification is given:

(1) Perityphlitic abscess—

(a) completely encapsulated,  
(b) communicating with cecum and eventually extending into adjacent tissues.

(2) Abscesses originating from an appendicitis but located distant to the cecum—

(a) pelvic abscess,  
(b) subphrenic abscess (not discussed),  
(c) intraperitoneal abscess somewhere else in the abdomen.

A number of good illustrations elucidate the author's points—filling defects, displacements, irritability of bowel, abscess cavities filled or lined with contrast medium, stenoses, etc. For differential diagnosis, tuberculosis, fungus infections, and invaginations must be considered, besides extra-intestinal pathology, such as parametritis, abdominal metastases, ovarian tumors, etc.

This is an interesting paper, and well worth reading.

HANS A. JARRE, M.D.

## BLOOD CHANGES

**Researches on the Blood of Radiologists.** Jacques Lavedan. *Radiophysiologie et Radiotherapie*, 1930, Vol. I, Fasc. IV, 477.

This paper is based upon the results of repeated blood examinations in a large number of persons of both sexes, engaged in X-ray and radium work. These comprise radiologists, technicians, and the general personnel of the Radium Institute of the University of Paris. The conditions of work as regards protection, hours of work, and holidays are given in detail, and these appear to be in conformity with accepted international standards. Only in the case of workers with the radon extraction apparatus was the possibility of considerable exposure present, although it was found that in some cases in which theoretically adequate protection had been provided, small defects were present which were capable of rectification. It was found that there is a very great variation in the effect of exposure to radiation on the blood in different individuals.



In some cases, definite changes were found after only a few weeks of exposure, while in others, working under identical conditions, no changes were found even after years of exposure. The commonest modification found in the blood picture is an increase in the mononucleated cells, either relative, with a diminished total leukocyte count, or absolute, with a normal or increased total count. (Under "mononucleated cells" are included all varieties of lymphocytes, mononuclears, and transitional cells.) In the most marked cases there may be a true inversion of the ratio of mononuclear to polymorphonuclear cells. In the opinion of the author this change cannot be considered as of grave importance. There is no evidence that the resistance to infection is lowered, nor can it be regarded as a pre-leukemic condition. It was found that a holiday of a few months or even weeks resulted in a return of the blood count to normal, or, at any rate, in a marked amelioration of the condition.

The author believes that the occurrence of these changes in the blood of X-ray and radium workers is always to be regarded as an indication that the protection is insufficient, even when the latter appears to be theoretically perfect, and that the blood counts can always be restored to normal by increasing the protection. Great importance is attached to the maintenance of a strict discipline in X-ray and Radium Departments, in order to insure that the rules of personal protection shall not be relaxed under any pretext whatever. However good the protection, it is urged that all X-ray and radium workers be submitted to blood examinations three or four times a year, since the blood, being the most radiosensitive tissue in the body, can give the earliest indication of injury from radiation.

WALTER M. LEVITT, M.B., D.M.R.E.

**The Behavior of the Blood Phagocytes in Irradiated Guinea Pigs.** Ludwig Pincussen. *Strahlentherapie*, 1930, XXXIX, 103.

The phagocytosis in the blood of guinea pigs before and after exposure of the animals

to a quartz mercury vapor lamp and a Vitalux lamp was studied by the author. From the ear, 0.1 c.c. of blood was taken, blown into a paraffinized test tube containing 0.5 c.c. of a solution which was made up by dissolving 0.5 gram NaCl and 0.4 sodium citrate in 100 c.c. of water. This was shaken well and then hydro-kollag 300 J. D. Riedel-E. de Haën added. The latter had been diluted with water twenty times, centrifuged ten minutes at 2,000 revolutions, and the resulting suspension was used for the experiments. Two drops of the blood suspension were added to the centrifuged solution, stirred with a glass rod, and then placed for one hour in a water bath at 37 degrees centigrade. After that, microscopic slides were made and stained with the Papanheim method. It appeared that the phagocytic action of the leukocytes, measured by the percentage of phagocytizing cells, was not increased by ultra-violet nor by visible light. An increase could be observed only following a rise of the temperature from 37 to about 39½ degrees centigrade.

ERNST A. POHLE, M.D., Ph.D.

**Fluctuations of the Blood Pressure Following X-ray Treatment and Their Clinical Significance.** Hans Pausdorf and W. Nell. *Strahlentherapie*, 1930, XXXVIII, 40.

Fluctuations in the blood pressure observed immediately following exposure to roentgen rays must be separated from those appearing 24 or 48 hours later. The blood pressure changes immediately after irradiation are irregular, while those manifesting themselves from one to two days after the treatment show definite cycles. Following an extensive treatment they may re-appear even between the twenty-fifth to the thirty-fifth day or between the fiftieth to the seventieth day. The lowering of the blood pressure is not due to the effect of roentgen rays upon the suprarenals but can be explained by a systemic reaction caused by the decay products formed during and following the exposure. They produce an increased irritability of the vasodilating nerves. The degree of the blood pressure

changes may be used as a factor in determining the prognosis and the proper interval between treatments.

ERNST A. POHLE, M.D., Ph.D.

**Further Studies of the Effect of Radiation on Blood Cholesterol in Malignant Disease.** Walter L. Mattick and Melvin C. Reinhard. *Jour. Cancer Research*, August, 1930, XIV, 426.

The authors determined the cholesterol content of the blood of twenty-five carcinoma patients, who had received high voltage therapy, at one-half hour intervals, beginning from thirty minutes before treatment to three hours afterwards. The Sackett modification of Bloor's method for the cholesterol content of the whole blood was employed. No characteristic change in the cholesterol level of the whole blood was noted in the three-hour period.

JOHN R. CARTY, M.D.

**Comparative Studies of Blood Injuries Following Roentgen Irradiation with the Old Treatment Technic and the Ray-proof Metalix Tubes.** Walter Fürst. *Strahlentherapie*, 1930, XXXVII, 659.

During the treatment of patients by the open tubestand method, a considerable amount of indirect radiation reached the body. The author has made an attempt to measure this undesirable amount of additional radiation by comparing the old technic with the modern procedure using Metalix tubes. The total radiation received by the patient with the two methods is in the ratio of seven to five. He believes that the systemic effect as well as the injuries to the blood are much less if the patient is treated by the modern method.

ERNST A. POHLE, M.D., Ph.D.

### BONE (DIAGNOSIS)

**Bone Changes in a Case of Chronic Empyema.** T. Dale. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 537.

The author reports in detail a case displaying the familiar bone changes seen in chronic

pulmonary diseases, in which the long bones revealed periosteal thickening and widening of the cortex. After rib resection and drainage the patient recovered from empyema. Examination by roentgenograms of the bones of the arms, legs, hands, and feet, a year and a half later, showed them to be practically normal. The author believes that these bone changes are due to a combination of toxemia and endocrine disturbances.

ALAN L. HART, M.D.

**Contributions to the Pathologic Osteology: (A) Unilateral Patella Partita; (B) Joint Formation in the Body of the First Rib.** A. Pickhan. *Röntgenpraxis*, Nov. 1, 1930, II, 969.

(A) The fact that the patella partita may be found on only one side is not definitely known. If it is bilateral there is usually no difficulty in the differential diagnosis from a fracture. Three cases of this congenital anomaly are described by the author, who states that it may be differentiated from fractures by the smooth edges of the dividing line, and by the absence of any callus.

(B) The formation of a joint in the body of the first rib is a very rare anomaly. Such a case is described and some reproductions are shown.

H. W. HEFKE, M.D.

**The Symphysis Pubis in the Roentgen Examination of the Sacro-iliac Joint.** W. Edward Chamberlain. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 621.

The author demonstrates that the ordinary roentgen examination of the sacro-iliac region does not demonstrate the presence of sacro-iliac relaxations or subluxations. The technic used by the author consists of five films—a stereoscopic pair in posterior projection, with the symphysis pubis and the entire pelvic brim in the field; a lateral projection centered at the lumbosacral junction, and two anterior projections, the patient standing, one with the patient's entire weight borne on the right leg, and the other with his weight on the left leg.

These latter films, made with the weight bearing on one leg only, serve to demonstrate radiographically a difference in elevation of the pubis, the upward movement of this bone serving as the long arm of a kymographic recorder to demonstrate an abnormal degree of rotatory motion in the sacro-iliac joint, hence making possible the diagnosis of "sacro-iliac relaxation." In the author's series of cases, the side of acute back symptoms is almost always the same side as that showing the high pubis. With this technic, normal individuals were first studied and normal movements were measured at the symphysis pubis in the male and non-pregnant female. The article is well illustrated.

J. E. HABBE, M.D.

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**A Contribution to the Etiology of the So-called Talalgia.** J. Odessky. *Röntgenpraxis*, Dec. 1, 1930, II, 1092.

Certain bone changes, which may be demonstrated by a roentgenologic examination, are the cause for the so-called talalgias. These changes consist of the formation of a spur on the lower surface of the heel and proliferative changes of the upper and posterior part of the os calcis. This latter process is an osteoperiostitis in the region of the insertion of the tendon of Achilles. Any infection, and not gonorrhea alone, may be the etiological factor. It cannot be said definitely at the present time whether or not cholera may be considered as a causative factor. The pains which accompany this are usually due to the inflammation of the bursa and the osteoperiostitis on the upper and posterior portions of the os calcis. Surgical removal of the spur does not always relieve the pain.

H. W. HEFKE, M.D.

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### BONE (THERAPY)

**Fractures of the Os Calcis.** Giuseppe Roto. *Clinica Chirurgica*, 1930, VI, No. 5, p. 483.

This article, which is a statistical study of one hundred cases and a clinical review of fifteen cases, is primarily concerned with a

discussion of the two types of treatment, namely, operation and manipulation and immobilization. Fractures of the os calcis represent 1.49 per cent of all fractures and 3.95 per cent of fractures involving bones of the foot. The author is an advocate of the bloodless method, for which he shows after-results at least not worse than those obtained by operative procedures. The patient is allowed to walk on the fifth day and physiotherapy is started on the fortieth day. Operation is advised in the avulsion fractures of the posterior tuberosity and arthrodesis in bad sequelæ. Ankylosis occurs spontaneously if the articular surfaces of both the os calcis and astragalus are involved.

The os calcis is crossed by four systems of trabeculæ. Between the anterior apophysis and thalamic, both of which run vertically, there is a sort of medullary cavity which constitutes a weak point in crushing fractures. The plantar system is horizontal and the system of Achilles runs in the direction of the tendo achillis.

Fractures of the os calcis are classified by Destot and Morel into four types: Fractures of the body of first, second, or third degree, varying from a subthalamic fissure to the bursting of the whole bone; fractures of the greater apophysis; fractures of the lesser apophysis, and fractures of the posterior tuberosity. The great majority of fractures of the os calcis result from a crushing mechanism. The lesion starts with a deepening of the thalamus where the various systems of trabeculæ converge to form a solid wall; crushing of the body occurs next, followed by irradiation of lines of fracture to the posterior tuberosity. These fractures may be associated with fractures of the inferior third of the bones of the leg or with the other bones of the tarsus.

The X-ray examination is made in the lateral and antero-posterior directions. Sometimes atypical positions are chosen in order to direct the central ray parallel to the planes of fracture. Stereoscopic views are occasionally made. It is of interest to note that ten cases of fractures of the body showed enlargement of the transverse diameter in the antero-posterior films. The X-ray examination is espe-

cially important because it shows the position of the fragments and is the only guide to the proper manipulation of the fracture previous to immobilization.

The author's personal method of treatment is described. The article is well illustrated and a good bibliography is appended.

V. WITTING, M.D.

**The Effect of Irradiated Ergosterol on the Healing of Experimentally Produced Fractures in Animals.** Howard A. Swart. *Jour. Bone and Joint Surg.*, April, 1930, XII, 360.

Leg fractures were studied in forty rabbits and twenty rats, half on a standard diet, and half receiving in addition small doses of viosterol. Roentgenograms taken at eight-day intervals, and tissue from animals killed at intervals of five days failed to show significant differences between the treated animals and the controls.

PAUL C. HODGES, M.D.

**The Relationship between the Hypophysis and the Formation of Callus in Bone: An Experimental Study.** A. Spinelli and Ferdinando Talia. *Archivio di Radiologia*, July-October, 1930, VI, 748.

In a series of experiments carried out on dogs with fractured limbs in which the hypophysis was irradiated, the authors found the following: (a) after irradiation of the hypophysis with stimulating doses (1) precocious formation of bony callus, (2) more rapid evolution of the callus, and (3) greater osteoblastic formation and greater periosteal reaction; (b) after inhibiting doses (1) delayed formation of callus, (2) delayed development.

E. T. LEDDY, M.D.

**Recovery from Fracture of the Neck of the Femur in a Nonagenarian.** Roscoe C. Webb. *Ann. Surg.*, December, 1930, XCII, 1112.

Roentgenograms of a ninety-three-year-old woman, taken on the day of injury, showing an intracapsular fracture of the neck of the left femur, with the distal fragment displaced

upward about one inch and rotated outward, and then again four months later, taken in abduction, showing the fracture to be in perfect position, with no absorption of the femoral neck, are unusually convincing. The author used the artificial impaction method of Cotton, and followed with the Whitman abduction and a plaster cast for three months. Besides general nursing care the patient was made to lie on her abdomen for one hour, three times daily. The fracture was set four days after the injury. An excellent portable roentgenogram was obtained of the fracture while the patient was under general anesthesia, and before the plaster cast was applied.

F. B. MANDEVILLE, M.D.

## BONE DISEASES (DIAGNOSIS)

**Kienböck's Disease of the Semilunar Bone.** N. Porro. *Archivio di Radiologia*, July-October, 1930, VI, 690.

The author reports and discusses, from a clinical and roentgenologic point of view, six cases of Kienböck's disease.

E. T. LEDDY, M.D.

**The Roentgenological Differentiation of Benign and Malignant Diseases of the Bones.** Robert Kienböck. *Med. Klinik*, Nov. 7, 1930, XXVI, 1655.

Between the terms "benign" and "malignant" are many grades, and the exact differentiation of them is hard to make. Only the osteomas (cartilaginous exostoses) are absolutely benign; only the blastomas (carcinomas and sarcomas) are absolutely malignant. Even in these groups, some are more benign than others (metastases of a thyroid carcinoma, adenocarcinoma). The chondromas of the skeleton should be called "semi-malignant"—they might stay benign or might degenerate into chondrosarcomas. In this group should be named also the lymphosarcomas, myelomas, xanthomas, and lipoidomas. Giant-cell tumors and the generalized osteitis fibrosa cystica are "pseudo-malignant." They are only bone dystrophies and not real tumors—both stay be-

nign and do not develop into sarcomas. Paget's disease is somewhat different; in from 3 to 5 per cent of all cases, a sarcoma develops, although the disease *per se* is benign and chronic. Some purely infectious bone diseases can be called malignant, as they progress rapidly and lead to the death of the individual. No single clinical symptom which is pathognomonic is known. The roentgen signs also are not so definite that one alone proves or disproves the benign or malignant character. Chondromas, bone cysts, and carcinomatous metastases might give very similar pictures. The differential diagnosis between sarcomas and hematomas, tuberculosis, syphilis, and purulent osteomyelitis is sometimes very difficult. It is not possible to give an easy guide for making a diagnosis and differentiating benign from malignant lesions. The entire roentgenologic picture, sometimes only with the help of the clinical findings, leads to a correct diagnosis.

H. W. HEFKE, M.D.

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**A Case of Generalized Osteitis Deformans (Paget), with Secondary Malignant Degeneration.** Viggo Genner and Harald Boas. *Acta Radiologica*, 1930, XI, Fasc. 4, No. 62, p. 398.

The authors describe a case of generalized osteitis deformans which developed a sarcoma of the scapula. The possible etiologies of Paget's disease are discussed. The pathology and roentgen findings of osteitis deformans are described in detail.

M. J. GEYMAN, M.D.

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**Osteochondritis Dissecans, Considered from the X-ray Standpoint.** Gösta Jansson. *Acta Radiologica*, 1930, XI, Fasc. 1, No. 59, p. 33.

Perthes' disease, Osgood-Schlatter's, Köhler's, Kienböck's, etc., have now been collected under one head as epiphyseal necroses.

In 1888, König announced his theory of spontaneous, aseptic necrosis in epiphyses, with the separation of necrotic bone as the result; he believed that trauma was only a

contributory factor added to an unknown basic cause. Other students of this disease held that injury was the sole etiologic factor. This view has not been substantiated by experimental research.

In 1922, Lieck identified osteochondritis dissecans with the other epiphyseal necroses. He believed the underlying cause was of an endocrine nature.

The author upholds Axhausen's theory that aseptic necrosis in an epiphysis results from an embolus and the consequent infarct. Localized bone necrosis, produced experimentally by an electric current, shows a pathologic picture resembling that of osteochondritis dissecans as well as Perthes' and Köhler's diseases. While the infarct is developing and before there are any loose fragments of bone in the joint, the patient has only mild rheumatic pain; but after the separation of the pieces of necrotic bone and cartilage, the patient develops the typical symptoms of sudden pain and fixation of the joint. Jansson believes that the lesions in the epiphyses are analogous to the anemic infarcts seen at autopsy in various organs. He states that the cartilage is not involved in the necrosis but is undermined by the necrotic process in the bone itself. Slight trauma may cause the affected area of bone to be torn off, carrying a section of normal cartilage with it. He has studied a large number of cases of traumatic "joint mice" and has never found them to contain normal joint cartilage. He believes they probably result from trauma to an arthritic joint, and consist of fractured fragments of pathologically changed bone. Films of the joint in these cases have not showed defects in the condyles of the femurs.

Osteochondritis dissecans usually occurs in young adults, although cases are seen in older persons. It is commoner in men than in women, may be bilateral, and is most often found in the knee and in the medial condyle of the femur. As a rule, the patient gives no history of any significant injury preceding the onset of symptoms. Roentgenograms are the most important method of diagnosis. It is essential that both antero-posterior and lateral films of the affected joint be made. The typical case presents on the films a large or

small area of bone destruction near the articular surface of the medial condyle of the femur. This defect may appear empty or may contain small pieces of bone. It does not protrude beyond the articular surface. After the fragments have separated and fallen into the joint, one can usually see an irregular defect in the condyle, as well as the free bone fragments in the joint. Small "joint mice" may be connected by a thin strand, with the defect in the femur.

The author reports ten cases of osteochondritis dissecans in persons ranging from 21 to 46 years of age. Two of the patients were women; eight were men. He gives the clinical history and operative findings, in addition to the X-ray evidence. The roentgenograms of the joints are supplemented by films of the fragments of bone removed from the joints at operation. These "joint mice" are seen to consist of both bone and cartilage; the bone sometimes shows areas of rarefaction and bone destruction. In some instances these free bodies consisted of cartilage in which were embedded small fragments of bone. Some of them had been fractured, and a few had one surface entirely covered with cartilage. He emphasizes the apparent impossibility of so much bone destruction occurring in the short time that generally elapses between the trivial injury, often recalled by the patient, and the onset of the symptoms of osteochondritis dissecans. It is his belief that this strongly destructive character of osteochondritis dissecans speaks for an embolic origin rather than a traumatic one, and he concludes that it forms an etiologically distinct group of joint diseases.

A. L. HART, M.D.

**Two Cases of Unusual Localization of a Chronic Bone Abscess (Brodie).** A. Mariupolsky. *Röntgenpraxis*, Nov. 1, 1930, II, 996.

The clinical and radiological appearances of chronic bone abscesses are well known. Of the nine cases observed by the author, two were found in the patella. This localization has not heretofore been described. The history and the clinical and surgical findings are described

in detail. Clinically, the knee joints were affected secondarily. The localization of these abscesses is usually around the epiphyses, but the two cases reported by the author and those published by other authors prove that the small bones may also be attacked.

H. W. HEFKE, M.D.

**Idiopathic Osteopsathyrose.** Leon Prusak and Natan Mesz. *Acta Radiologica*, 1930, XI, Fasc. 2, No. 60, p. 175.

The authors detail the history of the knowledge of this disease, starting a century ago with Lobstein, who was the first to describe the anatomical bone changes. Not until 1891 was the blue coloration of the sclera noted. At present the classical picture of this disease consists of (1) fragility of bones; (2) slate blue sclera, and (3) disturbances of hearing. The auditory symptoms are usually present in adults, but absent in children. There are abortive cases exhibiting only one of the cardinal symptoms. This disease often has a heredofamilial distribution, although it may skip a generation and often does not affect all the members of a family. It does, however, occur sporadically now and then.

The most prominent symptom is the fragility of the bones. The osseous changes, as seen on the roentgenogram, are: (1) thinning of the cortex; (2) widening of the marrow cavity; (3) calcium deficiency; (4) multiple fractures. The periosteum and epiphyses are not involved. Any bone may be affected, but the long bones, especially of the legs, suffer most frequently. The fragility of bones may reach such a degree that even a vigorous muscle contraction will produce a fracture. Some cases, with over a hundred fractures have been reported. These fractures commonly occur in infancy and early childhood, reach their height of incidence during adolescence, and are rare after 26 years of age. They often cause so little pain that the patient is unaware of them and their discovery is first made by the X-ray examination. The callus which forms is well-developed but so poor in calcium that it throws a faint shadow on the films of the bones. The healing proceeds with moderate rapidity and is often so com-

plete that it is difficult to recognize the sites of earlier fractures on roentgenograms. Most of the fractures occur spontaneously without serious injury, or even while lying in bed. Great deformity of the limbs may result from numerous fractures.

The blue color of the sclera is thought to be due to an unusual transparency of this coat of the eye-ball, permitting the choroid pigment to show through. The skull shows protuberances in the forehead, occiput, and temples. These cranial deformities plus relaxation of the structures in the middle ear, plus otosclerosis, are considered as the probable cause of the disturbances in hearing that develop during adolescence. Other inconstant symptoms are as follows: changes in electrical reactions of the muscles, thinning of the hair, trophic changes and pigment deposits in the skin, abnormal secondary sexual characteristics, corpulence, and hypothyroidism.

In the differential diagnosis there must be considered: (1) osteomalacia; (2) fractures in rachitic children; (3) osteogenesis imperfecta. The X-ray examination will not distinguish between idiopathic osteopsathyrose and osteomalacia: clinical data are necessary. Rachitic children never show so many fractures as patients with idiopathic osteopsathyrose: furthermore, the rachitic fracture develops a strong callus rich in calcium, and the cortex in rickets is thickened and the epiphyses involved in contra-distinction to idiopathic osteopsathyrose. Osteogenesis imperfecta presents a pathological picture very similar to that of idiopathic osteopsathyrose, but runs a different clinical course. Children afflicted with the former disease are often born with fractures or sustain fractures in the first days of life, are always very delicate, and usually die in very early childhood: whereas, patients with idiopathic osteopsathyrose are well-built physically and have a good prognosis as to life, while their fractures come on in later childhood and reach their peak during adolescence. Possibly these two diseases represent the same entity, occurring in different periods of life.

Nothing definite is known of the pathogenesis of idiopathic osteopsathyrose. Some students believe it is a developmental defect;

others that it is of endocrine origin, and still others that it is based on chemical changes in the composition of the bones.

The diagnosis is easy in cases presenting two of the cardinal symptoms, but is likely to be very difficult when only the bone fragility occurs. The authors report three cases as follows, two of which were typical, and the third showed multiple fractures and a chronic, organic disease of the brain:

(1) This case, a girl of 12 years, exhibited multiple fractures, blue sclera, heredo-familial tendency, corpulence, and precocious puberty.

(2) This case, a boy of 2½ years, showed the characteristic personal symptoms, but no heredo-familial tendency.

(3) This case, a boy of 8 years, failed to present the heredo-familial traits, but presented typical bone changes. He had epileptiform attacks and pyramidal symptoms, and was an imbecile as well.

The article is illustrated by a number of plates showing the physical state of the patients, and bone injuries and deformities.

A. L. HART, M.D.

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Melorheostosis (Léri) and the Generalized Osteitis Condensans or Osteopoikilia (Albers-Schönberg). A. Kahlstorf. *Röntgenpraxis*, August 15, 1930, II, 721.

A new case of melorheostosis is described by the author. This rare bone affection is a disease which attacks the bone of only one extremity in a segment-like band of osteosclerotic bone, and which, contrary to other bone changes, is not generalized nor present in separated foci. It appears that the bony sclerosis begins during the time of bone-growth in childhood or adolescence. The clinical symptoms, which usually appear late, are slight compared with the massive bone changes. In the author's case, the band-like lesion suggests a congenital anomaly, nothing definite being known about the etiology or pathogenesis. The ten cases of this disease so far described in the literature are reviewed and a bibliography is given.

Another rare bone disease is the generalized

osteitis condensans (Albers-Schönberg), also called osteopoikilia. The twelve cases heretofore described in the literature are briefly reviewed, and another case is added. Multiple, small, dense areas were found scattered through the extremities. One has to do apparently with an anomaly of ossification which is clinically of no importance and leads to no symptoms.

H. W. HEFKE, M.D.

## BONE TUMORS (DIAGNOSIS)

**A Contribution to Chondromatosis of the Joints.** Hofmann. *Röntgenpraxis*, Sept. 15, 1930, II, 842.

Chondromatosis of a joint is usually limited to one joint alone. In the case reported by the author, the knee joint and elbow joint were involved. Traumatic influences are not responsible for this disease, but it may be caused by a development of these tumors from embryonal cells. Differential diagnostic difficulties do not often exist. However, arthritic changes may be associated with this disease.

H. W. HEFKE, M.D.

**Pathological Fractures in Primary Bone Tumors of the Extremities.** Bradley L. Coley and George S. Sharp. *Am. Jour. Surg.*, August, 1930, IX, 251.

Pathological fracture occurred as a complication in 22.7 per cent of a series of 185 primary bone tumors of the extremities. This occurred in 25.7 per cent of endothelial myeloma, in 25 per cent of giant-cell tumor, and in 21.3 per cent of osteogenic sarcoma.

While it was found that three-fourths of the tumors occurred in the lower extremities, pathological fractures are most common in the upper extremities, and the upper end of the humerus was the region of greatest susceptibility to fracture. Fracture was the initial symptom in one-fifth of all the cases, but it did not occur as an initial symptom in any of the endothelial myeloma cases.

The life expectancy of a patient with osteo-

genic sarcoma in whom a pathological fracture has occurred is shortened 60 per cent. All the patients with fracture through giant-cell tumor are living, one to eight years. Fracture was followed by union in 3 of the 7 cases of endothelial myeloma; in 7 of the 9 cases of giant-cell tumor, and in none of the 26 cases of osteogenic sarcoma.

Pathological fracture may be postponed, or even prevented entirely, by early and continuous support. The failure to immobilize a limb in which a pathological fracture has already occurred may predispose to early dissemination.

HOWARD P. DOUB, M.D.

## CANCER (DIAGNOSIS)

**The Clinical Manifestations of Primary Bronchial Carcinoma.** Elmer H. Funk. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1879.

This essay is based on an analysis of the clinical features presented by sixty-one patients with primary carcinoma of the bronchus, in whom the diagnosis was verified by histologic examination of tissue removed. The predominance among men and the incidence after the age of 35, particularly from 35 to 45, are factors of significance in diagnosis. The author quotes Weller that the type of carcinoma occurring in the hilum, comprising perhaps 90 per cent of all cases, is practically always bronchiogenic. The clinical features vary greatly, depending on the following factors: (1) the location of the neoplasm and the rapidity of its growth; (2) the degree of bronchial obstruction produced; (3) the presence of secondary infection and suppuration; (4) the pressure on adjacent structures; (5) the occurrence of pleural involvement, which is not infrequently associated with effusion, and (6) the influence of local and general metastasis. The relative frequency of the local symptoms was as follows: cough, 88 per cent; expectoration, 67 per cent; pain, 72 per cent; hemoptysis, 45 per cent; dyspnea, 50 per cent. The general symptoms of weakness and loss of weight follow, as a rule, the occurrence of the local symptoms, and were sufficiently evident to be



noted as a part of the present illness by the patient in 80 per cent of the cases.

In extra-thoracic metastases any organ may be involved. An early and significant finding, clinically, is metastasis to the supraclavicular nodes. In most instances extra-thoracic metastases were late phenomena. Fried and Buckley found central nervous-system metastases in fifteen of thirty-seven patients with bronchiogenic cancer. The primary tumor may be overlooked. The roentgenologic evidence may be most valuable in determining the presence and location of the tumor, especially when the hilar mass is sufficiently large and not obscured by the many secondary pathologic changes which occur in the lung and pleura. When these are present the roentgen picture may resemble numerous other pulmonary lesions.

Bronchoscopic observation represents the most recent and important advance in thoracic diagnosis, and is the only method by which an early diagnosis of bronchial newgrowth can be made, with reasonable certainty in the vast majority of patients. Certain conditions which cause confusion, but which a complete study should exclude in the majority of cases, are: tuberculosis; bronchial obstruction from other causes; pulmonary abscess; syphilis; pneumoconiosis, and pleurisy. Generally, the prognosis is bad, and a fatal outcome occurs within a relatively short period of time.

C. G. SUTHERLAND, M.D.

**Diagnosis and Treatment of Early Cancer of the Breast.** William L. Hearst. Jour. Iowa St. Med. Soc., September, 1930, XX, 400.

The early recognition of cancer of the breast is very important, for not until a reasonably accurate diagnosis is made will an operation for its removal be permitted, and the earlier the operation the more hope of cure. At present, operation is the only method whereby we may hope for a complete cure. The great majority of breast tumors are malignant (85 per cent or more according to Mayo), and a fair proportion of the benign ones develop malignancy. All tumors not positively proven to be benign should be removed, and the re-

moval should be *in toto*, with all infected and enlarged glands in the axillary space or any other place. After such an operation the breast should be radiated thoroughly and for a sufficient length of time. In more advanced cases the pectoralis major and fascia and muscle of the pectoralis minor should be removed, with the glands in all the spaces and supraclavicular area, extending to the chest wall. X-ray treatments should then be given as soon as possible and continued until all suspicion of recurrence is past.

W. W. WATKINS, M.D.

**A Case of Carcinoma of the Thymus, with Extensive Metastases, in a New-born Child.** George V. Bedford. Canadian Med. Assn. Jour., August, 1930, XXIII, 197.

This case presents a number of features which are unique, *viz.*, the combination of primary carcinoma of the thymus, with metastases in the liver, lungs, bones, and skin. Primary carcinoma of the thymus is rare, and metastases in the skin of an infant are exceedingly rare.

The child at birth was covered with a generalized eruption which was partly pustular and partly hemorrhagic.

X-ray examination four days after birth showed enlarged thymus, infiltrated shadows in the lungs, spontaneous fracture of four ribs, and rarefaction areas in both femora and both tibiae and fibulae.

Wassermann reaction was negative on two tests. Sections of tissue examined in the Department of Dermatology and Syphilology of the Mayo Clinic proved to be carcinoma of the thymus, with metastases in bones, lungs, liver, and skin.

L. J. CARTER, M.D.

**The Diagnosis and Treatment of Cancer of the Stomach.** Penn Riddle. Texas St. Jour. Med., September, 1930, XXVI, 348.

Of the deaths from cancer, 25 per cent are due to cancer of the stomach. The outstanding progress in the early diagnosis of cancer of the stomach has been due to the more extensive use of the X-ray, very little progress

having been made in the early recognition of the disease from the interpretation of clinical symptoms. Of the patients coming to the Mayo Clinic with cancer of the stomach, one-half are operated upon, and one out of four has an operable lesion. According to Bal-four, the X-ray will correctly disclose from 96 to 98 per cent of organic gastric lesions, and three out of four of these are malignant. The problem is to train people to come early in the development of gastric symptoms. The treatment at present is entirely surgical. The X-ray is of little value in determining operability, and this can be learned only by exploration.

W. W. WATKINS, M.D.

**Primary Carcinoma of the Ureter.** Henry J. Lindner, Rigney D'Aunoy, and R. J. Mailhes. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 290.

A case of primary carcinoma of the ureter is reported, being the forty-eighth case on record and the eighth diagnosed before operation, with a *résumé* of the salient clinical and pathological features of all recorded cases. No etiology can be ascribed, concurrent calculus being present in only eight cases. Hematuria, pain, and renal and ureteral dilatation are most frequently encountered. Diagnosis is difficult, but is greatly facilitated by a careful history, the use of cystoscopy, pyelography, and pyeloureterography. Radical operation is the treatment.

W. W. WATKINS, M.D.

**The Diagnosis of Cancer.** Francis Carter Wood. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1141.

While it is perfectly possible to have the lay public absorb a certain amount of information concerning the symptoms of cancer, after such absorption has taken place and the desired reaction has occurred, the profession is not in a position, speaking generally, to render efficient service to those who apply for it. The medical profession, as a whole, is not yet prepared to accurately diagnose the disease which it is called on to treat, at a stage which permits of effective therapeutic attack, nor are

all surgeons or radiologists prepared to offer the proper therapy. The facts are, at present, that at least half of the malignant tumors which occur are so inaccessible as to render an early diagnosis in no sense possible, and, in addition, even the accessible tumors are so rarely diagnosed in the early stages that only about 20 per cent are susceptible of operative treatment, with a probability of cure. A small percentage of the inoperable tumors are available for curative radiation therapy.

The pathologist is assuming a position of importance which he has not held since tumor diagnosis began. Pathologic control is important in modifying the present attitude of some surgeons, that the breast of any woman over 35 years of age, containing a few nodules, should be promptly removed *in toto*. In the vast majority of cases, the diagnosis, whether on frozen or embedded material, rises no higher than the intelligence of the pathologist and the breadth of his experience. The need for better training of pathologists is stressed, and interesting suggestions are made as to methods of carrying this out. The pathologist of the future is to be called on to state the degree of malignancy of a tumor, and whether or not it is radiosensitive. Malignancy, it should be remembered, is a clinical phenomenon—not a morphologic one. The clinician and the pathologist must be much better trained in the diagnosis of tumors than they are at present.

C. G. SUTHERLAND, M.D.

**Primary Carcinoma of the Lungs and Bronchi.** E. V. Goltz. *Minnesota Med.*, September, 1930, XIII, 605.

The increase in carcinoma of the lung is not wholly apparent, but there is evidence to show that it is actual. Primary carcinoma of the lungs may arise from the columnar epithelium of the bronchi, from the mucous glands of the bronchi, or from the squamous epithelium of the alveoli. The forms arising from the bronchial epithelium vary greatly in size, color, and consistency; they may remain as small local nodules, with wide metastases, or may grow extensively into the lung tissue. Sooner or later there is obstruction to a bron-

chus. The type arising from mucous glands is rare and usually limited to the walls and submucosa of the bronchi. Those types arising from the pulmonary alveolar epithelium may be diffuse over a large area, or may be multiple and nodular. Primary carcinoma of the lung is prone to metastasize. A careful history will usually focus attention on the lungs, when physical examination and special examinations by bronchoscope, by X-ray alone or after lipiodol injection will give conclusive evidence. The X-ray examinations should be repeated to observe progress. Therapy by X-ray may relieve pain, but progress of the lesion is rarely ever affected.

W. W. WATKINS, M.D.

Some Notes on the Diagnosis of Carcinoma from the Blood Serum. Howard M. Jamieson. *Illinois Med. Jour.*, January, 1931, LIX, 40.

The writer gives a history of the various serological tests which have been used in an attempt to make an early diagnosis from blood serum. He has found a modified Botelho test most satisfactory.

The reagents used and the technic are as follows:

Reagent No. 1:

Formalin	1 c.c.
Sodium citrate	0.25 gram
Citric acid	4.74 grams
Pure iodine crystals	1 gram
Distilled water to	100 c.c.

Reagent No. 2:

Pure iodine crystals	1 gram
Potassium iodide	2 grams
Distilled water to	210 c.c.

The test is carried out by adding 0.25 c.c. of serum to be tested to a small test tube containing 2.0 c.c. of Reagent No. 1. Mix thoroughly without foam and add 0.7 c.c. of Reagent No. 2 slowly from a pipette. A flocculent precipitate forms which, in most cases, dissolves on thorough mixing (in all cases in which a normal or non-cancerous serum is being tested). A further 0.2 c.c. of Reagent No. 2 is added, forming a further precipitate

which persists after mixing, if the reaction is positive.

Reactions are graded as follows:

Heavy precipitate after	0.7 c.c.	4 plus
Light precipitate after	0.7 c.c.	3 plus
Heavy precipitate after	0.9 c.c.	2 plus
Light precipitate after	0.9 c.c.	1 plus
No precipitate negative.		

All 1 plus reactions should be considered as doubtful, and should be repeated, with a new specimen of blood, if possible. The author believes a positive Botelho test, with an increased antitryptic index, especially if this be 3.0 or over, sufficient to warrant a diagnosis of cancer in any suspicious case.

He arrives at the following conclusions:

1. The most important thing in connection with cancer is an early diagnosis.
2. Of the several available tests, the most promising are the Botelho reaction and the antitrypsin index estimation used together.
3. Too much confidence should not be placed on either test used alone.
4. The Botelho test may be doubtful, but never really negative, in cases of cancer which have been treated with radium, while treatment by the X-ray does not seem to affect the reaction.

5. The reaction may be doubtful, but never really positive, in cases of syphilis treated with arsphenamine, but not in other methods of treatment. It may, however, be definitely positive in cases of degenerating gummas.

C. H. DEWITT, M.D.

## CANCER (THERAPY)

The Present Status of the Treatment of Carcinoma of the Cervix Uteri. Erwin Zweifel. *Am. Jour. Obst. and Gynec.*, November, 1930, XX, 595.

The author comprehensively reviews the works and recommendations of various authorities on this subject, in both the fields of gynecology and radiology. The difficulty in appraising and comparing the relative cures obtained by the different methods, is cited. This difficulty is due to the personal equation entering into the grouping of the cases. The absolute cures are comparable, and he states that

the results in the best published statistics on treatment by irradiation are about the same as the results in the best published statistics for surgery.

The advantages enjoyed by irradiation are the absence of fear in the patient, resulting in earlier treatment; the low immediate mortality; its value in both operable and inoperable cases; the constant advancement and improvement in technic, while surgery has reached a *status quo*. The disadvantages of irradiation are the complications which may result even with the most careful technic just as in surgery, or inadequacy of the treatment. Proficiency in radiation therapy is more difficult to achieve than proficiency in surgery.

The treatments available are surgery, irradiation, or a combination of the two. Radiation therapy should always have a definite place in the plan of treatment for uterine carcinoma. The value of irradiation is conclusively demonstrated in the statistical reports of various authorities, in which their cures were doubled by routine post-operative irradiation over their cures by surgery alone, which include reports by Kroenig and Gauss, Warnekros, Zacherl and Lundwahl, Adler, Breitschneider, Giesecke, Lehotsky-Semmelweiss, and many others. The value of routine post-operative irradiation in carcinoma of other structures, as the ovary, breast, etc., has been conclusively demonstrated by Seitz and Wintz, Eymer, v. Franque, v. Jaschke, Strassmann, Schaefer, Breitschneider, Flatau, Aubert, E. Zweifel, Meyer, Buchholz, and others. Stoeckel combines pre-operative radium therapy, radical surgery, and post-operative roentgen therapy.

The author, a gynecologist, concludes that surgery and post-operative irradiation combined, give better results than surgery alone. The relative value of surgery and radium is not determined.

The discussions by Ward, Brettauer, v. Mikulicz, Healy, Stone, McGlinn, Taussig, Farrar, and Zweifel are well worth reading.

JACOB H. VASTINE, M.D.

with Various Combinations of Wave Lengths. Bernard P. Widmann and J. L. Weatherwax. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1930, XXIV, 540.

The authors are of the opinion that the progress of radium and roentgen therapy must depend upon the development of physical principles and technics which permit the delivery of greater quantities of radiation to the tumor areas. Clinical experience indicates that certain cancers are radiosensitive and radioresistant. Highly cellular cancers are extremely malignant and also highly radiosensitive. The authors maintain that the "skin erythema dose" should be standardized. They have found 800 r to be a safe erythema dose, from an experience of 15,000 doses of roentgen rays. Clinical results point to a selective action of gamma radium rays (with filtration equivalent of 2 millimeters of platinum). Combinations of different short wave lengths of roentgen rays, in conjunction with gamma radium packs to the same skin area, will increase the skin tolerance for radiations 30 or 40 per cent. Clinical impressions justify the inference of improved end-results in advanced cancer by the systematic application of combined short wave length radium and roentgen rays.

J. E. HABBE, M.D.

Modern Methods in the Treatment of Carcinoma. Fraser B. Gurd. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 784.

This paper is based on observations made during a somewhat prolonged trip to several of the more important British and European clinics.

Despite the fact that the injection into the body of certain colloidal substances, more especially lead and selenium, have been followed in a small number of cases by good results, the usefulness of such a procedure has been very problematical. During recent years there have been added to surgery, as means of combating cancer, three new methods, electrocoagulation, X-rays, and radium. Electrocoagulation has the advantage, as compared with the scalpel, of not running the risk of spread-

A Clinical Evaluation of Radium and Roentgen Therapy in Advanced Cancer,

ing cancer cells, and so has gained for itself a definite place in the attack on carcinoma.

The use of radium in the treatment of cancer has opened up an entirely new field. Special attention has been attracted to the subject since the publication of the work of Professor Forssell, of Stockholm. The Stockholm method of treatment of carcinoma, by means of radium and X-rays, differs from that practised in Paris and Brussels, and that used for the most part in London, in that larger doses of radium are employed for shorter periods.

In the treatment of skin cancers at Stockholm, the radium plaque is used for rodent ulcers. For other skin cancers, intubation is used. In the treatment of carcinoma of the lower lip, for instance, of the size of a ten-cent piece, five or six tubes, 1.5 cm. in length and containing 10 mg. of radium each, with a platinum-gold filtration equal to 1.0 mm. of lead, are inserted about and beneath the tumor. These are removed in from two and a half to four hours.

The Stockholm clinic is very enthusiastic about the use of the radium bomb or "telecurie therapy," as it is called in Paris and Brussels. They have two bombs, one containing from one to two grams of radium, and the other five grams. Radon is not used in Stockholm, chiefly, it would appear, because they believe it is dangerous for the technicians preparing the seeds or tubes.

Roentgen-ray therapy is extensively used, as is electrocoagulation, the latter especially in the case of mouth tumors and in carcinoma of the vulva. A common routine in the mouth tumors is, first, the X-ray, then electrocoagulation, and, at the same sitting, the insertion of radium tubes.

At Stockholm, in contrast with London, radium is not employed in carcinoma of the breast, except in cases of local or glandular recurrences. The routine treatment is one or two pre-operative courses of X-radiation, employing five ports of entry. The total dose over each port during each course is one or one and three-quarters of an erythema dose. Operation is undertaken six weeks after the last pre-operative radiation. Following operation, one, two, three, or sometimes four post-

operative radiations are carried out at intervals of from three to six months.

Buccal tumors are treated in Stockholm by means of electrocoagulation. In the anterior two-thirds of the tongue, the tissues immediately about the coagulated area are intubated with radium tubes.

They do not use radium in carcinoma of the rectum.

The most striking thing about the Stockholm clinic is the thorough organization for the protection of the operators as well as in the "follow-up" of the treatments. In Paris, the author found the work with radium much less organized for observation than that in either Stockholm or London, and, inasmuch as the work in London is largely based on that done in Paris, he believes it is better for the visitor to spend more time in London than in Paris. In London the treatment of carcinoma of the breast is carried out extensively by means of radium implantation. The work of Dr. Geoffrey Keynes, at St. Bartholomew's Hospital, and that of Dr. Stanford Cade, at Westminster Hospital, are specially mentioned. Dr. Cade has added to the method of implantation, that of distance radiation by means of radium in Columbia paste shields applied to the front and back of the chest. Cade, however, does not support the use of radium to the exclusion of surgery in the early cases. In London, they are not as enthusiastic about the use of the radium bomb as they are in Stockholm. The author does not believe the London technic in the use of the bomb is as good as that of Stockholm. At St. Bartholomew's Hospital both radium needles and radon seeds are used, but the physicians there believe the use of the needles is the better procedure.

In the treatment of carcinoma of the mouth, including the tongue, buccal mucosa, pharynx, and the palate, Cade depends entirely upon the use of radium and does not employ coagulation. In the treatment of the glandular areas, he uses block dissection of one or both sides of the neck, and follows with a radium collar after the wound is healed.

In the treatment of cancer of the rectum, Cade believes that ultimately a radium technic will be evolved which will be superior, but at

the present time surgery should be employed in the operable cases.

L. J. CARTER, M.D.

**Cancer of the Breast.** Albert Soiland. *Jour. Cancer Research*, March, 1930, XIV, 128.

The writer is convinced that treatment of breast carcinoma in all stages would be effective if early radiation were instituted, regardless of whether or not surgery is undertaken. Post-operative radiation has probably added 10 per cent to the so-called clinical or five-year cure of all breast cases operated on. The author questions the value of several recent statistical reports showing five-year results in breast cancer obtained by surgery only, radiation alone, and by the combination of the two means. He feels that these reports are not fair to radiology, because the radiation therapy was not administered in many instances by those competent to do so in a scientific manner, and with adequate equipment. He feels that in the absence of any other apparent curative agent, radiation promises to become the active treatment factor in cancer of the breast, with surgery as an ally for general reconstructive work.

JOHN R. CARTY, M.D.

**The Treatment of Carcinoma of the Tongue.** Milton Friedman. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 284.

In planning the treatment of a case of carcinoma of the tongue, the therapist must first decide which objective to aim at: cure or palliation. Radiation is dangerous and either kills or cures, and only experience can teach one to differentiate between hopeless and favorable cases. In the preliminary treatment, external radiation by high voltage X-rays is directed to both sides of the neck, which should total four 25 per cent erythema doses to each side of the neck. If the tumor responds at all to this, the dose should be repeated before going on to local treatment. Interstitial radiation with radium needles is the best for local treatment. The author advocates platinum needles 27 and 35 mm. in length, each with 2 mg. of radium. These

should be inserted around the periphery of the lesion. Each needle should remain in place 100 hours, so that 200 milligram-hours may be delivered to each cylindrical area 1 cm. in circumference. The glands draining the tongue area should be thoroughly removed by surgical excision. If a persistent, painful radium scar or ulcer results, it should be excised with the endotherm knife.

W. W. WATKINS, M.D.

**Diet of Carcinoma Patients.** W. Caspari. *Strahlentherapie*, 1930, XXXVII, 719.

The author discusses briefly the present status of our knowledge concerning the influence of diet on carcinoma in man. From a study of the literature, it appears that the diet must not be too rich. It should not be limited, however, so much that there is danger of under-nourishment. A few carbohydrates, fresh vegetables, and sugar are recommended; a certain amount of bread and some potatoes are permissible. Albumin and fat can be given freely. The desirable administration of Vitamin A is best carried out by feeding cod liver oil. Uncooked food is contra-indicated; large amounts of eggs and milk should be avoided; no liver or tomatoes should be given. Salt may be used according to the habits of the patient. This type of diet is meant for patients after operation or irradiation. Plenty of fluid should be taken first and then gradually reduced. A regular function of the bowels is very important.

ERNST A. POHLE, M.D., Ph.D.

**The Radium Treatment of Cancer of the Tongue (Symposium).** Stanford Cade. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 771.

This symposium was contributed, at the meeting of the British Medical Association in Winnipeg, by Stanford Cade, of London; Douglas Quick, of New York, and G. E. Birkett, of Manchester. In many respects there was a remarkably close agreement among these three workers, and as a result there emerged a fairly authoritative declaration on the radium treatment of buccal carcinoma.

For treatment of the primary growth all were

agreed on the advantages of radiation over surgery, but whereas Cade and Birkett favored radium needles, Quick preferred radon seeds. In the opinion of the first two authorities it was difficult, with seeds, to obtain a uniform intensity of radiation, not only because the intensity of radiation rapidly diminished within a period of four days, but also because the small seeds could not be so accurately placed as the larger needles.

For the treatment of operable metastases of the neck, all the speakers favored free surgical excision. When there were large inoperable metastases the glands should be actively treated by radium needles in large doses, and the balance of opinion favored open operation as the method by which this should be carried out. For early cases in which no palpable metastases could be found there was sharp divergence of opinion as to the method of treatment to be employed. Birkett advocated a waiting policy, provided the patient reported for examination once a month. Cade and Quick, on the other hand, believed that the neck should never go untreated. Cade advocated treatment by needling, using the closed method, or external treatment by means of the radium collar. Quick employed heavily filtered high voltage X-radiation, and more recently a 4-gram radium element pack. Speaking of the radium bomb at the Westminster Hospital, Cade felt that it was not an economical method of using radium. Quick stressed the importance of cleaning the mouth before treatment was begun. The general impression given out was that radium was superior to surgery alone.

L. J. CARTER, M.D.

**Carcinoma of the Cervix Uteri.** Cornelius Oliver Bailey. *Texas St. Jour. Med.*, September, 1930, XXVI, 351.

Since 30 per cent of cancer in the female involves the uterus, and 90 per cent of uterine cancer originates in the cervix, the consideration of this lesion is of great importance. The earliest stages of the disease appear as (1) a hard nodule in the substance of the cervical lip, (2) papillary outgrowths from the lip or the canal, or (3) excavation or cauliflower growth.

Cervical cancer involves the pelvic nodes in less than one-third of the cases. The treatment of cancer is both educational and technical. From the technical standpoint, there is a two-fold problem: (1) eradication of the local lesion and maintenance of body resistance at the highest point of efficiency; (2) the study of the general condition of the patient in order that the natural body resistance to cancer may be kept at the highest point of efficiency. The treatment and prognosis are largely dependent on intelligent study of the biopsy specimen, and no line of treatment is justified until a pathological report is available. The method of treatment advocated is usually from four to six thousand milligram-hours of heavily filtered radium to the cervix and broad ligament regions. This is supplemented with medium wave roentgen-ray therapy in massive doses over the pelvis by "cross-fire" distribution. After this a "follow-up" system is essential to the proper handling of the cases.

W. W. WATKINS, M.D.

**Factors Influencing the Treatment of Rectal Cancer.** George E. Binkley. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1971.

The treatment of rectal cancer is a perplexing but interesting problem, on account of the variable factors associated with this disease at the time a definite diagnosis is determined. Early recognition of rectal cancer, while the tumor is small and the disease is localized, offers many advantages to successful treatment. The two methods of treatment that have proved of greatest value in this disease are radiation therapy and surgery. In a miscellaneous group the best results are obtained by varying the dosage and technic in accordance with the clinical and pathological features of the given case.

The two forms of radiation therapy that have proved of greatest value in deep-seated tumors are external applications of radium and roentgen rays, and interstitial applications of radon, filtered by 3 mm. of gold. The surgical procedures that offer the greatest possibilities are the abdomino-perineal and the perineal types of operation, while a colostomy affords a certain degree of palliation in the

inoperable group. It appears more appropriate now to classify cases as favorable and unfavorable. Favorable patients are those presenting strong possibilities of being rendered free from disease by surgery, radiation therapy, or the combined use of radium and surgery. Unfavorable patients are those suited only for palliative measures. The physical condition of the patient should receive primary consideration, as the severity of the treatment should not exceed his endurance. Moreover, the degree of palliation in the unfavorable group frequently depends upon the physical condition. The anatomic location and the accessibility of the cancer within the rectum may greatly influence the selection of treatment. Through recognition of the type of malignancy before treatment is undertaken, many patients with incurable, highly malignant cancers will be saved the unnecessary annoyance of radical procedures. On the other hand, patients with tumors of the lowest degrees of malignancy will be rendered free from disease or provided with the highest degree of palliation. The grade of malignancy suggests a solution of the problem in determining the most appropriate type of operation. A moderate sized, low-grade rectal cancer, in which the disease appears to be more or less localized, may be completely eradicated by surgical dissection, while a similar surgical procedure in the case of a tumor of the highest grade of malignancy, but similar in size and fixation, is more likely to be detrimental than beneficial. Highly malignant tumors are cellular and usually radiosensitive and require a comparatively small dosage. Overdose in this type tends to produce necrosis and sloughing. In certain instances the employment of interstitial irradiation is contra-indicated. Tumors of low-grade malignancy lend themselves well to interstitial irradiation, although they require for devitalization a comparatively large dosage of gold seeds. Cancers occurring in patients below the age of 30 are usually highly malignant.

A long history of mild subjective and objective symptoms, associated with a comparatively small tumor, without deep infiltration, suggests a low malignancy, while a sudden

onset of severe symptoms, accompanied by a comparatively extensive mass, indicates a more highly active process. The most adequate determination is by the combined application of the clinical and histologic studies.

CHARLES G. SUTHERLAND, M.D.

**Cancer of the Esophagus: Analysis of Eighty-two Cases.** E. P. McCullagh. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 288.

This study includes 82 cases seen at the Cleveland Clinic for the period from 1921 to 1928. Of these, 77 per cent were men, the average age being 59 years. No patient recovered, the average duration of life in men being 9.9 months and in women 12.5 months. Fifty-seven patients received some sort of treatment.

In 92 per cent of 74 cases in which an X-ray examination was made, a positive diagnosis of cancer of the esophagus was made. In 9 cases the examination failed to show the lesion on the first examination; in 2, a second examination identified it. One case, positive on X-ray examination, was negative to esophagoscopy, but was found to be positive three months later. Cardiospasm was diagnosed by esophagoscopy in one case, while the X-ray revealed a definite growth one month later. Fifty-seven patients received some sort of treatment; X-ray was employed in 14 cases, radium in 16, gastrostomy in 17, dilatation in 7, and esophagectomy in 3.

Surgical removal of cancer of the esophagus is a formidable procedure and hardly justified. The best treatment is the application of radium through an esophagoscope, and this does little good. A few cases have been reported as benefited by the X-ray.

W. W. WATKINS, M.D.

**Present Methods of Radiation Treatment of Carcinoma and Their Results. III.—The Saturation Method of Pfahler and Kingery.** Hans Holfelder. *Strahlentherapie*, 1930, XXXVII, 696.

The principles of the saturation methods as advocated by Kingery and Pfahler are briefly discussed. One of the author's assistants studied the skin reactions following exposure



to roentgen rays by using different intervals. The preliminary results are given and illustrated by two photographs of the irradiated skin.

ERNST A. POHLE, M.D., Ph.D.

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**The Treatment of Carcinoma of the Body of the Uterus.** William Neill, Jr. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 412.

Adenocarcinoma of the body of the uterus is rarer than cervical cancer, grows more slowly, and tends to remain restricted to its primary corporal origin. Metastases to distant or neighboring structures, however, are more common than in the cervical group. In this paper the author emphasizes his treatment of this disease with radium, reporting results and the percentage of five-year cures. Taking all groups treated at the clinic prior to five years ago, there were 109 patients; 76 have died, counting 6 patients lost sight of as dead, and 33 are living, making a total five-year-cure rate of 33 per cent. The author does not attempt a prognosis from the standpoint of histological grading. He concludes that, as with cancer elsewhere, the greatest hope for cure lies in an early diagnosis. In operable carcinoma of the body of the uterus, radium offers a method of treatment comparable to surgery, as it obviates the primary mortality and can be used safely in those cases presenting bad surgical risks—it offers the possibility of a cure or definite palliation to a number of inoperable and recurrent cases. When there is any doubt as to the extent of the disease, operation alone or operation combined with radium therapy is the treatment of choice.

J. E. HABBE, M.D.

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**The Principles of and Some Results in the Radium Treatment of Buccal Carcinoma.** G. E. Birkett. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 780.

This paper is the final contribution toward the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

Radium has improved out of all recognition the outlook in buccal carcinoma. All squamous epitheliomas of the mouth and

tongue are radiosensitive, some more so than others, and there is now unanimity of opinion that prolonged irradiation with gamma rays of low intensity yields the best results. The problem, then, should be mainly one of the insertion or application of the radium. The author is unhesitatingly in favor of using radium needles in preference to seeds.

Metastasis to the cervical glands, which always occurs by embolism, cannot be adequately treated either by external radiation or by blind insertion of needles through the skin. The author's practice is to reflect flaps, as in a block dissection of the neck, divide the sternomastoid, and insert needles in the anterior and posterior triangles about 2 cm. apart. These are left in position about eight days.

The results of treatment in the author's series of cases is as follows: 38.7 per cent 3-year "apparent cures"; 47.3 per cent 2-year, and 60 per cent 1-year, for the primary site. When the primary and secondary sites are considered, the percentages are 27.5, 36, and 45, respectively. Improvement in results will depend on several factors: the two most important are earlier diagnosis and concentration of radium treatment at larger centers.

L. J. CARTER, M.D.

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**Malignancy of the Body of the Uterus.** O. L. Norsworthy. *Texas State Jour. Med.*, October, 1930, XXVI, 440.

In a series of 264 cases of cancer of the uterus examined from 1921 to 1928, 42 were corpus cases, two of which were sarcoma, two were chorio-epithelioma, the others being the usual adenocarcinoma. Of these, 27 were treated with radium alone, and 15 with radium and hysterectomy. Of the 27 patients treated with radium, 11 are living and well five years after treatment; of the 15 treated by radium and hysterectomy, five are living and well at the end of five years. While 42 is not a large enough series from which to draw conclusions, the number suggests that irradiation may become the treatment of choice for malignancy of the body, just as it has in malignancy of the cervix.

W. W. WATKINS, M.D.

**Treatment of Intra-oral Cancer, with Special Reference to Radium Therapy.** Douglas Quick. *New York St. Jour. Med.*, Sept. 15, 1930, XXX, 1094.

Practically all our experience with radium has been gained during the past fifteen years, and a certain number of failures during this period must be charged up to the accumulation of experience. Surface applications were first used, but were discontinued as far back as 1917, with only three cases in which complete and permanent regression of the disease was obtained. From 1917 to 1925 results improved through the use of unfiltered emanation seeds. In 1925, these were replaced by the gold emanation tubes which filter all the softer rays, lessening the local reaction, pain, and necrosis.

The treatment of intra-oral cancer is a surgical problem and must be approached as such. The radium irradiation is the backbone of treatment of intra-oral cancer. Radium must be accurately placed and with accurate dosage, and other associated measures must be used. X-radiation is a necessary complement in all cases of intra-oral cancer, unless large amounts of radium are available for distance radiation. Operative surgery is frequently necessary in the mouth for drainage, for access to growth, and for dealing with disease in bone; also in the neck in early, definite involvement of adult epidermoid carcinoma. Four hundred and seventy-three cases of cancer of the tongue are reported upon, of which 22.4 per cent were clinically free from disease for from five to ten years after treatment.

W. W. WATKINS, M.D.

**Uranium-thorium Colloid in the Treatment of Carcinoma.** George T. Pack and Fred W. Stewart. *Jour. Cancer Research*, March, 1930, XIV, 152.

The authors administered a mixed uranium-thorium colloid intravenously to eight patients with advanced carcinoma, according to the method of Hocking. There was evidence of temporary benefit in one case. In the other seven cases there were no signs of improvement of any sort. In two patients, there was

evidence of kidney damage, although no autopsy confirmation was obtained. Autopsy was done upon two cases. The Kupffer cells of the liver showed the usual type of liver picture seen with many colloid metals. The spleen showed phagocytic material in the reticulo-endothelial apparatus. Desiccated liver and spleen were found to be radio-active, but the tumor tissue from the same cases showed no evidence of radio-activity.

JOHN R. CARTY, M.D.

**Radium Treatment of Cancer of the Tongue.** Stanford Cade. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 771.

This paper is a contribution toward the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

In the last few years this form of therapy has made rapid strides, following the results obtained by Regaud, who introduced the method of needling, now in most general use. In the series of cases under review, all were treated except those with a life-expectancy of only a few weeks. No attempt is made to separate the operable from the inoperable group.

All the cases were treated by implantation of radium needles into and around the tumor, seeds being used exceptionally when local conditions demanded them. The needles used contained 0.6 mg. and 1.3 mg. of radium, and were fully screened by 0.5 mm. and 0.6 mm. of platinum, respectively. The period of treatment was seven days. The amount of radium used depended on the extent of the disease. Treatment of the primary lesion was nearly always followed by treatment of the lymphatic area in the neck, either by needling through the closed method or by use of a radium collar.

The cases treated cover a period of five years, from April, 1925, to April, 1930. The total number was 253, distributed as follows: tongue, 169; cheek, 23; tonsil, 12; palate, 28; lip, 21.

Disappearance of the primary lesion was obtained in 126 cases, that is, 74 per cent. The number of local recurrences, as distinguished from primary failures, was 43, that

is, 25 per cent. In many of these latter the lesion was completely eradicated by subsequent treatment. The percentage of cases requiring a second treatment was definitely greater among those treated by radon seeds than among those treated by needles.

The main conclusions reached are: (1) the superiority of needles, and (2) the necessity of treating *all* cases over the cervical gland area. Here needling by either the closed or open method is preferred to surface application.

L. J. CARTER, M.D.

**Radium and Surgery in Cancer of the Tongue.** Douglas Quick. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 774.

This paper is another contribution to the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

Two points are emphasized: (1) that the combined use of radiation and operative surgery offers several advantages in the treatment of epidermoid carcinoma in general, and (2) the treatment of epidermoid carcinoma is steadily approaching a more reasonable, accurate, and efficient basis.

Histologic study of the relative degrees of cell differentiation or potential malignancy of tumor processes has been most enlightening from the therapeutic standpoint. It shows very clearly the reason for surgical failure in many instances, and at the same time explains some of the most spectacular reactions to radiation. The undifferentiated growth, highly malignant, prone to early and widespread dissemination through both lymphatics and blood stream, presents obviously a poor surgical risk. On the other hand, it is highly radiosensitive. The fully differentiated tumor process is more orderly in its development. Metastasis occurs, as a rule, later in the disease, and even then tends to remain within a limited area. In such cases it is but reasonable to expect relatively better results from operative measures. The more adult the growth the more radioresistant it becomes. The reaction to radiation is not nearly so spectacular, and yet, if the process be controlled by this means, the

assurance of permanency of the result is much greater.

Martin and Quimby have shown that adult epidermoid carcinoma requires from seven to ten erythema doses throughout the tumor-bearing area to produce complete and permanent control of the growth. The anaplastic growths, on the other hand, respond completely to a dosage range of from three to six skin erythemas, depending on the relative degree of differentiation.

As three skin erythema doses is the safety limit for safe irradiation of the tongue by external methods, it is evident that this must be supplemented by some means in the case of growths showing any degree of cell differentiation. Interstitial radiation must be employed.

Inasmuch, then, as treatment detail is based on the histology of the growth it is essential that a biopsy be done early and in all cases. The theoretical objections to this procedure are overridden by the advantages of the information obtained.

Oral hygienic measures are of prime importance.

In the Memorial Hospital the same principles of treatment are followed as presented before the First International Congress of Radiology in London, 1925, and published in the *British Journal of Radiology*, March, 1926. External radiation of greater intensity than formerly employed is now being used, augmented recently by a radium pack of 4 grams. For interstitial radiation, radium emanation, or radon, in gold capillary tubes, with a filtration of 0.3 mm. gold, is employed.

If the growth be bulky, fungating, and markedly infected, the implantation is followed in a few days by cautery removal of the condemned area.

Secondary invasion of bone by growth, infection in bone, or devitalized bone caused by irradiation, calls for surgical removal.

The treatment of the lymph nodes in the neck consists of heavily filtered external radiation of the maximum intensity consistent with tissue tolerance, and from both sides. If a palpable node of adult type epidermoid carcinoma is present, complete unilateral dissec-

tion is done under local anesthesia. Before the wound is closed, filtered radon seeds are implanted at any suspicious points. No post-operative radiation is employed. If the node is inoperable, no dissection is attempted, but radon seeds are implanted. All necks with bilateral metastatic nodes are regarded as being surgically inoperable, and incurable except in very rare instances. External radiation is used as a palliative measure only in these advanced cases. Metastatic nodes from anaplastic epidermoid carcinoma are treated by radium alone, used externally in most instances, but supplemented by implantation of radon tubes.

An analysis of ten-year clinical results is appended.

L. J. CARTER, M.D.

### CHEMICAL<sup>1</sup>

**The Crystal Structure of Silver Cyanide.** H. Braekken. *Kgl. Norske Videnskabers Selskab., Trondhjem, Forhandlinger*, v. 2, 1929, II, Medd. No. 48, 169.

AgCN recrystallized from  $\text{Na}_2\text{CO}_3$  or  $\text{K}_2\text{CO}_3$  solutions showed the same diffraction pattern as the original powdered material. The crystals were needles, 3–4 mm. in length, and showed prisms of the first order, though a few with second-order prisms were found. The crystals are of the hexagonal quadratic form. Laue photographs show a ditrigonal roentgen symmetry. The parameter is 4.60 Å.U. and the angle  $81^\circ 14'$ . The space group is  $C_3^2$ . Ag ions are located 3.5 Å.U. from C or N. The forces are strongest in the direction of the needle axis. Braekken proposes to call this type a chain lattice, a linear analog of layer lattices.

CHEMICAL ABSTRACTS.

**Structure Produced by Rolling of Metals.** E. Schmid and G. Wassermann. *Metallwirtschaft*, 1930, IX, 698.

A piece of technical sheet zinc was cold-rolled in one direction to a thickness of 0.02 mm. and X-ray photographs taken at various angles to the sheet in three planes: (1) in the

direction of rolling, (2) perpendicular to and (3) at an angle of  $45^\circ$  to the direction of rolling. The photographs are summarized in a pole diagram showing the position and the intensity of the base faces. The same procedure was followed with a piece of magnesium annealed 1.5 hours at  $600^\circ$  and cold-rolled to 0.03 millimeter. The orientation of Mg is much simpler than that of Zn. The formation of the orientation of the two metals is explained by the changes in the single crystal, and the characteristic difference by the difference in the mechanical twinning. The heterogeneity of the orientation of rolled Zn is proved by preliminary tests.

CHEMICAL ABSTRACTS.

**X-ray Study of Certain Esters of Cellulose and of Glucose.** A. Nowakowski. *Compt. rend.*, 1930, CXCI, 411.

Distearic and dilauric esters of cellulose showed only a microcrystalline structure, and no fiber pattern; but fiber patterns were obtained from pentacetic, pentalauric, and pentapalmitic esters of glucose, with an identity period along the fiber axis 5.28–5.39 Ångström units. The fibrous forms of these esters have fibers all in the same direction, with the aliphatic acid chains at right-angles to the length of the fiber.

CHEMICAL ABSTRACTS.

**False Lines in X-ray Grating Spectra.** J. M. Cork. *Phys. Rev.*, Aug. 15, 1930, XXXVI, 665.

Certain false lines may be obtained on the photographic plate in addition to those due to defects in the grating because of the generally employed arrangement of slits, X-ray source, and diffraction grating in X-ray spectroscopy.

CHEMICAL ABSTRACTS.

**Orientations of the Molecules in Naphthalene and Anthracene Crystals.** Kedareswar Banerjee. *Indian Jour. Physics*, 1930, IV, 557 (cf. *Chem. Abs.*, XXIV, 3410).

It has been found that the intensities of X-ray diffraction from naphthalene and anthracene crystals do not conform to the ori-

<sup>1</sup>Reprinted by permission from *Chemical Abstracts*.

entations of the molecules along any cell face. By the "trial and error" method of analysis it has been found that the molecules are inclined to the cell faces, the correct positions being obtained by first placing them along the plane and then by two successive rotations about the "b" and the "c" axes. The rotations about the "b" axis for the two molecules in the unit cell are equal but opposite, while about "c" they are in the same direction in conformity with the space-group  $C_{2h}^5$ . The amounts of rotations for naphthalene are  $25^\circ$  and  $12^\circ$ , respectively, and those for anthracene are  $25^\circ$  and  $9^\circ$ . All the benzene rings in the same molecules are in the same plane and the rings are practically regular hexagons. The structure obtained, as the result of the present investigations, is in conformity with the magnetic and optical properties of these crystals.

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CHEMICAL ABSTRACTS.

Polymorphism of Sodium Sulfate. IV.—X-ray Analysis. F. C. Kracek and C. J. Ksanda. Jour. Phys. Chem., 1930, XXXIV, 1741.

Three forms of  $\text{Na}_2\text{SO}_4$  were detected:  $\text{Na}_2\text{SO}_4$  I, stable  $240^\circ$ ;  $\text{Na}_2\text{SO}_4$  V, stable at ordinary temperatures, and  $\text{Na}_2\text{SO}_4$  III, metastable below  $185^\circ$  but inert, when dry, at ordinary temperatures. X-ray patterns of the three forms and also of  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  are presented.

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CHEMICAL ABSTRACTS.

Liquid Structure and X-ray Diffraction in Liquids. Kedareshwar Banerjee. Indian Jour. Physics, 1930, IV, 541.

A theoretical explanation of X-ray diffraction effects in liquids is presented, consisting essentially of the application of the Boltzmann principle, as originally employed by Raman and Ramanathan, to analyze liquid structure. The method is modified so as to take into account the nature of the field of force surrounding the molecules. The intensity distribution in the diffraction pattern is worked out. The liquid structure is a degeneration of the crystal structure brought about by the thermal agitations, and hence some of the intense crystal diffraction lines give rise to liq-

uid diffraction maxima while others are quenched out. Simple cases of Na, K, A, and Hg are discussed fully and found to agree with the experimental results. Intensity distribution for rays diffracted by Hg is calculated according to theory and found to agree with the photographs given by Prins.

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CHEMICAL ABSTRACTS.

The Crystal Lattice of Iron Silicide,  $\text{FeSi}$ . H. Möller. Naturwissenschaften, 1930, XVIII, 734.

The results of Phragmen (Chem. Abs., XVIII, 3032) were verified. The compound was prepared from 33.0 g. Armco Fe and 17.0 g. Si in a Pythagoras crucible, Tammann furnace. Debye-Scherrer diagrams were made and measured. They gave a cubical translation lattice  $T_c$  with  $a = 4.467 \text{ \AA.U.}$  From this and  $d = 6.23$  it follows that there are 4  $\text{FeSi}$  in the unit cell. Only space group  $T^4$  with Fe in  $(uuu)$ ,  $(u + \frac{1}{2}\bar{u} + \frac{1}{2}\bar{u})$ ,  $(uu + \frac{1}{2}\bar{u} + \frac{1}{2})$ ,  $(\bar{u} + \frac{1}{2}uu + \frac{1}{2})$  and Si in  $(\bar{v}\bar{v}\bar{v})$ ,  $(v + \frac{1}{2}\bar{v} + \frac{1}{2}\bar{v})$ ,  $(\bar{v}\bar{v} + \frac{1}{2}\bar{v} + \frac{1}{2})$ ,  $\bar{v} + \frac{1}{2} - \bar{v}\bar{v} + \frac{1}{2})$  corresponds to the intensities measured,  $u = 0.1340 \pm 0.0020$ ,  $\bar{v} = 0.8445 \pm 0.0020$ . The distances of Fe and Si are 2.24, 2.34, and 2.52  $\text{\AA.U.}$ , min. for Fe-Fe 2.74  $\text{\AA.U.}$ , Si-Si 2.76  $\text{\AA.U.}$

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CHEMICAL ABSTRACTS.

Absorption of X-rays by Lithium. K. C. Mazumder. Phys. Rev., 1930, XXXVI, 347.

The mass scattering coefficient of lithium was measured for wave lengths 0.587–0.100  $\text{\AA.U.}$  For longer wave lengths the results can be expressed by the equation  $\mu/\rho = 0.94\lambda^3 + 0.162$ . Below 0.2  $\text{\AA.U.}$  there is a very rapid bending of the curve towards the axis  $\lambda^3$ .

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CHEMICAL ABSTRACTS.

X-ray Diffraction in Liquid Hexamethylbenzene. P. Krishnamurti. Indian Jour. Physics, 1930, IV, 449.

The liquid X-ray pattern consists of a strong inner halo (8.2  $\text{\AA.U.}$ ) and a weak outer one (4.2  $\text{\AA.U.}$ ), corresponding roughly to the [100] and [001] reflections of the crystal powder (7.7  $\text{\AA.U.}$ ; 3.7  $\text{\AA.U.}$ ). It is assumed

that the 4.2 Å.U. spacing of the liquid is caused by the thickness of the molecule; the other spacing represents periodicities in the plane of the benzene ring. The diminished structure-factor for the [001] spacing caused by the thermal agitation of the molecules in the liquid causes a diminution in intensity of the outer halo in the liquid. The outer rings of other benzene derivatives correspond to the thickness of the molecule.

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CHEMICAL ABSTRACTS.

**The Crystalline Structure of Hydrogen Sulfide and Hydrogen Selenide (II).** G. Natta. *Atti accad. Lincei*, 1930, XI, 749; cf. *Chem. Abs.*, XXIV, 4973.

The structures of  $\text{H}_2\text{S}$  and  $\text{H}_2\text{Se}$  were studied on crystallized material by means of X-rays. At  $-170^\circ$ ,  $\text{H}_2\text{S}$  has a cubic unicellular space lattice,  $5.778 \pm 0.003$  Å.U. on a side; volume  $192.8 \times 10^{-24}$  c.c.; containing 4 molecules of  $\text{H}_2\text{S}$ ; density (calculated) 1.166.  $\text{H}_2\text{Se}$  also has a cubic structure containing 4 molecules, side  $6.020 \pm 0.005$  Å.U.; volume  $218.2 \times 10^{-24}$  c.c.; density (calculated) 2.456.

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CHEMICAL ABSTRACTS.

**The Crystal Structure of Cadmium Chloride.** Linus Pauling and J. L. Hoard. *Ztschr. f. Krist.*, 1930, LXXIV, 546 (in English).

The unit of structure for  $\text{CdCl}_2$  is a rhombohedron, with  $\alpha = 36^\circ 02'$  and  $a = 6.23$  Å.U. containing 1 molecule. There is a layer structure along [0001], closely related to that of  $\text{CdI}_2$ . The Cl atoms are in approximate cubic close-packing. The relation of the  $\text{CdCl}_2$  and the  $\text{CdI}_2$  structures is discussed, and a list of similar compounds which crystallize in each type is given.

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CHEMICAL ABSTRACTS.

**The Absorption of Long Wave X-rays of 2-10 Å.U. in Light Elements.** Bernhard Woernle. *Ann. Physik* [5], 1930, V, 475.

This reports experimental determinations of the absorption coefficient of air, N, O, Ne,

A,  $\text{SO}_2$ ,  $\text{C}_3\text{H}_{12}$  vapors and  $\text{CCl}_4$  vapors in the range 2.3-9.9 Å.U., by means of a vacuum ionization spectrometer. A null method was used. From the experimental data, the coefficients of S, C, and Cl have been computed. The electronic absorption coefficient is not strictly a pure function of the product  $Z\lambda$ , systematic deviations being observed. The  $K$  level absorption energy change was found for S, Cl, and A, and was approximately equal to the ratio of the energy values of the  $K$  and  $L_1$  levels.

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CHEMICAL ABSTRACTS.

**Scattering of X-rays by Bound Electrons.** Saligram Bhargava. *Nature*, Sept. 13, 1930, CXXVI, 398.

Bhargava attributes the scattering noted by Dr. B. B. Ray (cf. *Chem. Abs.*, XXIV, 3705) to a special case of photo-electric emission. A beam of frequency  $\nu$  hitting a  $K$  electron loses energy equal to  $h\nu_k$  and will retain  $h(\nu - \nu_k)$  which may either continue, or be absorbed by the electron which is then ejected. This has been used by de Broglie and Robinson to obtain the energy levels of atoms. Dr. B. B. Ray, in *Nature*, Sept. 13, 1930, CXXVI, 399 (cf. *Chem. Abs.*, XXIV, 4213): The lines previously described as "modified lines due to the scattering of X-rays by bound electrons," would be better described as due to partial absorption of incident radiation by atoms. Further lines observed are given.

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CHEMICAL ABSTRACTS.

**X-ray Examination of Gelatin Micelles.** W. Abitz, O. Gerngross, and K. Herrmann. *Naturwissenschaften*, 1930, XVIII, 754.

The work of Katz and Gerngross has shown that gelatin gives a partly amorphous, partly crystalline X-ray diagram; stretched gelatin gives a collagen-like diagram. It appears on careful stretching that these diagrams are inter-related. The structure of gelatin is deduced in a manner similar to that for liquid crystals (Glamann, Herrmann, and Krummacher, *Chem. Abs.*, XXIV, 4438) on the basis of parallel long stretched molecules. The polypeptide chains are arranged parallel to

each other over part of their length, thus giving an almost crystalline structure, without strict identity of the units. The ends of the chains are not closely bound together, so that the micelles appear more or less "frayed," causing the amorphous part of the X-ray diagram. The "frayed" ends of the chains produce the intermicellary coherence of the gelatin. Greater orientation and coherence of the chains and fewer "frayed" ends are found in collagen and in stretched gelatin. By the structure described several of the properties of the substance are explained.

#### CHEMICAL ABSTRACTS.

The Chemical and Crystalline Structure of Several Complex Nitrites. A. Ferrari and C. Colla. *Atti accad. Lincei*, 1930, XI, 755; cf. *Giorn. chim. ind. applicata*, 1930, XII, 142.

The three nitrites  $K_2PbNi(NO_2)_6$ ,  $K_2PbCo(NO_2)_6$ , and  $K_2PbCu(NO_2)_6$  have similar cubic crystal structures, having 4 molecules for unit cell, and the sides and diameters are, respectively, 10.55, 10.49, 10.52 Å.U.; 3.5, 3.66, 3.56.  $2 K_3Co(NO_2)_6 \cdot 3H_2O$  has a similar cubic structure with 4 molecules, and side 10.32 Å.U. Probably there is no water of crystallization, the  $H_2O$  being enclosed in the space lattice, rather than held by the molecule itself.

#### CHEMICAL ABSTRACTS.

The Crystal Structure of the Normal Paraffins at Temperatures Ranging from that of Liquid Air to the Melting Points. Alex Müller. *Proc. Roy. Soc., London*, 1930, CXXVII-A, 417.

An X-ray investigation has been made of the structures of a number of normal paraffins ranging from pentane to triacontane, at liquid-air temperature, atmospheric temperature, and near the melting points. Linear expansion measurements show that the lengths of both the  $a$  and  $b$  axes increase considerably with rise of temperature, the coefficient of expansion of the  $a$  axis being three or four times as large as that of the  $b$  axis. The expansion of the  $c$  axis is very much smaller, and does

not exceed 0.1 of that of the  $a$  axis. These facts indicate that the forces which hold the atoms together in the molecule are different in magnitude from those which keep the molecules apart from each other; the chemical conception of the entity of the molecule is thus confirmed for the solid state. The higher members of the paraffin series crystallize in the so-called "normal" form previously described (Müller and Saville, *Chem. Abs.*, XIX, 1692) which is found to be stable between the melting point and liquid-air temperature. Differences in the behavior of the odd and even members begin to appear as the number of C atoms decreases, docosane and lower members existing in two alternative forms. Within a small range of temperatures near the melting point the normal form is stable, but at lower temperatures a second crystal structure appears and persists down to the temperature of liquid air. The change from one form to the other is reversible for docosane, eicosane, and octadecane. The change from the normal to the other form occurs between undecane and nonane in the series of the odd members. These abrupt changes in structure are discussed and a qualitative explanation is suggested. Observations taken in the immediate neighborhood of the melting point indicate that these substances tend to form layer structures, and it is shown how the normal form could be transformed into such a structure in a simple manner.

#### CHEMICAL ABSTRACTS.

Crystal Structure of Normal Paraffins. S. H. Piper and T. Malkin. *Nature*, 1930, CXXVI, 278.

Very pure specimens of four of the higher normal paraffins were classified according to Müller (preceding abstract). Hexacosane,  $C_{26}H_{54}$  and tetratriacontane,  $C_{34}H_{70}$ , exist in two stable forms at room temperature, one with the normal  $A$  spacing, and the other about 4 Å.U. shorter, but obviously not the  $B$  "second form." Hexacosane took the  $C$  form when crystallized from  $C_6H_6$  or EtOH, while a melted layer showed both  $A$  and  $C$  spacings. Tetratriacontane from  $C_6H_6$  gave only  $C$  spacings, while melted crystals showed only

the *A* form. Triacontane,  $C_{30}H_{62}$ , showed the *A* form under all conditions. Even-numbered hydrocarbons of 26 or more C atoms seem to crystallize in the *C* form, while the odd-numbered nonacosane,  $C_{29}H_{60}$ , crystallizes in the *A* form. This alteration of crystal habit is in accord with the behavior of the normal aliphatic acids and alcs.

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CHEMICAL ABSTRACTS.

**The Crystal Structure of Cementite.** Sterling B. Hendricks. *Ztschr. f. Krist.*, 1930, LXXIV, 534 (in English).

From data published by Westgren and Phragmen (*Chem. Abs.*, XVI, 2291; XVIII, 2093), a complete structure determination is made for  $Fe_3C$ . The space group is  $P_{\bar{6}}^{16}$ . Atomic positions are derived. The structure is of the co-ordination type.

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CHEMICAL ABSTRACTS.

**The Crystal Structure of  $Fe_2P$ ,  $Fe_2N$ ,  $Fe_3N$ , and  $FeB$ .** Sterling B. Hendricks and Peter R. Kesting. *Ztschr. f. Krist.*, 1930, LXXIV, 511.

Examination of published data for  $Fe_2P$ ,  $Fe_3N$ ,  $Fe_2N$ , and  $FeB$  show that these compounds have a non-ionic co-ordination type of structure (cf. preceding abstract).  $Fe_3N$  (cf. *Chem. Abs.*, XXIII, 2408, 4387) is hexagonal with N at 000;  $\frac{1}{3}$ ,  $\frac{2}{3}$ ,  $\frac{1}{2}$ ; and Fe at 0,  $\frac{1}{3}$ ,  $\frac{1}{4}$ ; 0,  $\frac{2}{3}$ ,  $\frac{3}{4}$ ;  $\frac{1}{3}$ , 0,  $\frac{1}{4}$ ;  $\frac{2}{3}$ , 0,  $\frac{3}{4}$ ;  $\frac{1}{3}$ ,  $\frac{1}{3}$ ,  $\frac{3}{4}$ ; and  $\frac{2}{3}$ ,  $\frac{2}{3}$ ,  $\frac{1}{4}$ . The unit cell contains 2 molecules and  $a = 2.695 \sqrt{3}$ ,  $c = 4.362$  Å.U. For  $Fe_2N$  the Fe atoms have the same positions as in  $Fe_3N$ , while N is at 000;  $\frac{1}{3}$ ,  $\frac{2}{3}$ , 0;  $\frac{2}{3}$ ,  $\frac{1}{3}$ ,  $\frac{1}{2}$ . Atomic positions are derived for  $Fe_2P$  and  $FeB$ . For compounds of this type a polyhedron of metal atoms is formed around each non-metallic atom, the former equidistant from the latter. The polyhedra are regular or distorted, so that the metal atoms have, along some elements, approximately the separation characteristic of the metal. If a compound  $R_aX_b$  consists of co-ordinated polyhedra having *N* corners, each corner is shared by  $Nb/a$  polyhedra. The sharing is usually of corners only, sometimes of edges, and less often of faces.

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CHEMICAL ABSTRACTS.

**Structure Investigation of Silver Permanganate.** Wilhelm Büsser and Karl Herrmann. *Ztschr. f. Krist.*, 1930, LXXIV, 458.

Both crystallographic and X-ray measurements were made on  $AgMnO_4$ . The crystals are monoclinic, the space group being  $C_{2h}^5$ . The unit cell contains 4 molecules and  $a = 5.66$ ,  $b = 8.27$ , and  $c = 7.12$  Å.U. The structure can be considered as a slightly deformed  $KMnO_4$  lattice. A density determination gave 4.49.

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CHEMICAL ABSTRACTS.

**The Structure of Silicates.** W. L. Bragg. *Ztschr. f. Krist.*, 1930, LXXIV, 237 (in English). (Cf. *Chem. Abs.*, XXIII, 5371.)

This is a summary of the present knowledge of silicate structures. Individual minerals and isomorphous groups are described and discussed. The various structures are classified as: (1) orthosilicates, with independent  $SiO_4$  groups; (2) complex Si-O groups, such as  $Si_2O_7$  or  $Si_6O_{18}$ ; (3) Si-O chains, as found in pyroxenes and amphiboles; (4) Si-O sheets, which are probably characteristic of mica-like minerals; (5) 3-dimensional Si-O networks. These groups show a progressive reduction in the Si-O ratio. There is a discussion of interatomic distances, isomorphous replacements, co-ordination numbers, and Pauling's rule of compensation as applied to silicates. Complete bibliography.

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CHEMICAL ABSTRACTS.

**Atomic Analysis by X-ray Spectroscopy.** T. H. Laby. *Trans. Faraday Soc.*, 1930, XXVI, 497.

The X-ray method of detecting the atomic constituents of a substance is compared with other methods, *viz.*: (1) chemical, (2) optical spectroscopic, and (3) positive-ray methods. Spectroscopic methods are in general to be preferred to chemical ones when only very small quantities of the sample are available, or when the unknown substance is present in only very minute traces. The X-ray method has the following advantages over the optical: simplicity and relatively short range of the X-ray spectrum due to a given atom; certainty of identification of lines of



elements according to Moseley's law; the fact that, for elements of nearly the same atomic number, the intensities of corresponding emission lines, excited with equivalent excitation potentials, are in the same ratio as that of the respective numbers of atoms of the elements in the mixture. The last consideration makes possible the use of the X-ray method for other than very small concentrations, a condition necessary for the quantitative interpretation of results obtained by the optical method. The X-ray method is probably more sensitive than the optical, although sensitiveness depends to a great extent upon the elements investigated and experimental technic. Elements have been detected in concentrations as small as 1 part in  $10^2$ . The experimental methods of X-ray analysis are briefly discussed, and a short description and an illustration of the apparatus are included. The importance of a satisfactory experimental technic is stressed.

#### CHEMICAL ABSTRACTS.

Separation of Carbon from Carbon Monoxide in Iron. III.—The Formation of Iron Oxides and Iron Carbides in the Solid Phase. Ulrich Hofmann and Edeltraud Groll. *Ztschr. f. anorg. u. allgem. Chem.*, 1930, CXCI, 414.

O-free CO was passed over pure Fe, prepared from  $\text{Fe}(\text{CO})_5$ . The solid phase was examined with X-rays by the method of Debye-Scherrer. Up to  $450^\circ$ , graphite and  $\text{Fe}_3\text{O}_4$  were found with little Fe and  $\text{Fe}_3\text{C}$ ; from  $450^\circ$  to  $650^\circ$ , graphite and FeO and small quantities of  $\text{Fe}_3\text{C}$ ; from  $450^\circ$  to  $650^\circ$ , graphite and FeO and small quantities of  $\text{Fe}_3\text{C}$ . Fe and  $\text{Fe}_3\text{O}_4$ ; above  $655^\circ$ , Fe, C and  $\text{Fe}_3\text{C}$  but no FeO or  $\text{Fe}_3\text{O}_4$ . At  $320^\circ$  and  $275^\circ$ , CO was passed over pure  $\text{Fe}_2\text{O}_3$ . X-ray examination showed  $\text{Fe}_3\text{O}_4$  and  $\text{Fe}_3\text{C}$  in the solid phase. Unknown lines were attributed to a C-rich carbide,  $\text{Fe}_2\text{C}$ , which is unstable at higher temperatures. Benzine vapors passed over Fe at  $700^\circ$  together with O-free  $\text{N}_2$  gave C, Fe and cementite in the solid phase. The results are discussed with reference to the phase diagram of Schenck (*Chem. Abs.*, XXII, 2132). Attempts to detect oxoasten-

ite in the solid phase were unsuccessful. According to Schenck (*Chem. Abs.*, XXII, 936), this occurs in carbonization above  $575^\circ$ . The CO-CO<sub>2</sub> analyses obtained at  $700^\circ$  are within this field but only cementite and  $\alpha\text{-Fe}$  were found in the solid phase. The latter was cooled both in  $\text{H}_2\text{O}$  and in liquid  $\text{N}_2$ , but since the mass is in the form of a fine powder because of the separation of C cooling may not be rapid enough to prevent decomposition of oxoastenite.

#### CHEMICAL ABSTRACTS.

### CHEST (DIAGNOSIS)

Neurofibroma Arising on the Pericardial Pleura. William L. Keller and George R. Callender. *Ann. Surg.*, October, 1930, XCII, 666.

A Filipino house servant, a woman of 38 years, complained of pain and tenderness in various joints, stiffness of one knee joint, and swelling and clubbing of the fingers. Roentgenographic examination of the thorax showed a tumor in the left lower chest which moved with the diaphragm. A phrenicotomy was performed and thirteen days later the tumor was removed. The tumor was encapsulated, with numerous vessels in its smooth capsule, and attached to the pericardium by a broad pedicle, 5 cm. in diameter, and to the lower lobe of the left lung by a smaller pedicle 2 cm. in diameter, over the course of the left phrenic nerve. It was irregularly oval in shape, weighed 660 grams, and measured 14 by 11 by 8 centimeters.

Following the operation the osteo-arthritis demonstrated some improvement. Reproductions of X-ray films of the chest before operation and one and one-half years later, showing no recurrence, are included.

F. B. MANDEVILLE, M.D.

Deformation and Displacements of the Hilum in Pulmonary Sclerosis and Pleural Adhesions. Guido Pescatori. *La Radiologia Medica*, May, 1930, XVII, 509.

This is a complete and comprehensive study of pulmonary kinematics. The author discusses the interpretation to be given, with dif-

ferent radiographic images of the chest, and illustrates his article with abundant radiographic material. Special emphasis is laid upon the movement of the hilum and its position, since it is considered by the author as the most eloquent factor in the diagnosis of pleural or pulmonary sclerosis.

The article is so detailed that it is impossible to give a complete abstract of it in restricted space.

L. MARINELLI.

**Syphilis of the Lungs.** Karl Herman. *Röntgenpraxis*, Oct. 15, 1930, II, 916.

Syphilis of the lungs is a very rare disease and can easily be mistaken for tuberculosis, carcinoma, or chronic pneumonia. Clinically, syphilis of the lungs may present itself in three types: (1) Syphilitic bronchitis; (2) chronic pneumonia; (3) chronic pseudophthisis. The roentgen appearance alone is not diagnostic. The Wassermann reaction and the result of specific therapy assist one in making a definite diagnosis. Two cases are described in detail in which the roentgenologic and clinical examinations and the success of anti-syphilitic treatment made the diagnosis of lung syphilis certain.

H. W. HEFKE, M.D.

**Further Studies on Cardiac Pulsation in Pneumothorax.** Alessandro Vallebona. *Archivio di Radiologia*, July-October, 1930, VI, 827.

In this study the author shows that jerky pulsation of the heart is most marked at the end of expiration, and is due to changes in pressure in the pleural cavity and altered relationship between the lungs and heart.

E. T. LEDDY, M.D.

**A System of Reading X-ray Films for Use in Sanatoria.** Duncan McRae. *Am. Rev. Tuberc.*, June, 1930, XXI, 811.

The system described by the author is the one used in the Manitoba Sanatorium, and he claims it has proven very satisfactory. This, in the main, consists of the use of certain letters, figures, and abbreviations to indicate the

presence or absence of certain conditions and their extent: thus "*RD up 2, tied*," we judge, means that the right diaphragm is elevated above the normal, and fixed. A system of this kind in an institution with a constant staff may work out satisfactorily, but a report of this nature would hardly be satisfactory if sent out to a physician not familiar with the language.

In an X-ray laboratory doing general work for varying groups of physicians, it would hardly prove practical. The fact, however, that it encourages detailed study and systematic reading recommends it.

S. C. BARROW, M.D.

**Bronchography—the Passive Technic.** F. H. Cooley. *Journal-Lancet*, Aug. 1, 1930, L, 373.

(*Abstractor's note*:—It is the custom in many places for the physicians to refer patients to radiologists for the introduction of opaque oils into the bronchi preparatory to X-ray examination. Any simplification of the technic will be welcome to radiologists, therefore.)

The use of the passive technic is based on the physiology of swallowing, which is partly voluntary and partly involuntary, the latter dependent upon the former. Sensory anesthesia of the anterior pillars of the fauces will abolish the reflex act, preventing elevation of the larynx and, therefore, opening of the esophageal orifice. Any substance entering the pharynx under such conditions must pass down the larynx.

After cleansing the mouth, the anterior surface of the anterior tonsillar pillars is swabbed with a 10 per cent solution of cocaine until the swallowing reflex is abolished, usually three or four swabbings. Then three or four c.c. of a 3 per cent cocaine solution is given the patient, who is told to lean back, protrude the tongue, lean toward the side to be filled, and breathe naturally. The solution will be aspirated into the lung. Then the faucial pillars are again swabbed, and the patient is given 10 c.c. of iodized oil, which is aspirated into the lung in the same manner as the cocaine solution. After expectoration of sali-

va, another 10 c.c. is introduced. This is an ideal procedure for bronchography.

W. W. WATKINS, M.D.

**The Hairline in the Roentgenogram of the Lungs.** L. Schall and F. Hoffmann. *Röntgenpraxis*, Nov. 1, 1930, II, 977.

In good roentgenograms of the lungs, one may occasionally see a very fine line in the right mid-chest, either straight or slightly curved, which is the so-called "hairline." Hotz found this in 6.5 per cent of his cases, Schönfeld in 13.5 per cent, and the authors in 16.1 per cent in 4,508 films. The authors are of the opinion that this fine line represents the interlobar pleura, the presence of which does not necessarily mean an old or recent interlobar pleurisy. It is probable that the normal interlobar pleura may also cast this shadow in certain cases.

H. W. HEFKE, M.D.

**Roentgenology of the Upper Respiratory Tract.** Henry K. Pancoast. *Jour. Am. Med. Assn.*, Nov. 1, 1930, XCV, 1318.

The upper respiratory tract from the nasopharynx to the carina has recently become a very important field for roentgenologic diagnosis. The most important factor in diagnosis is a careful study of the soft structures during an examination of the neck. This includes fluoroscopic observations of the movements or changes in lumen of the various portions of the tract during respiration, speech, and swallowing, and the making of roentgenograms for records. In all instances the chest should be included, and especially in infants and young children.

Since the beginning of Hay's work the members of the author's staff have realized that the only way of determining accurately the potential dangers of the thymus in infancy is through a study of its effects on the upper respiratory tract and not by an estimation of its dimensions. The technic of examination is explained and discussed.

The author states that practically all of the pathologic conditions presented by the larynx and neuromuscular disturbances show some

recognizable phenomena or abnormal appearances, many of which are characteristic.

The study of phonation and the swallowing act is essential in all cases. Both of these functions are described in his essay.

CHARLES G. SUTHERLAND, M.D.

**The Clinical and Roentgenologic Value of the Lateral Chest.** C. H. Warfield. *Illinois Med. Jour.*, December, 1930, LVIII, 461.

The lateral chest is not used as much as it should be, because of the difficulty in securing uniformly satisfactory results. The technic used is 118 P.K.V., 50 ma., one-half second, at a distance of 7 feet, for the average adult of 150 pounds. The patient stands with the affected side toward the film, crossing the arms in front of him, and, grasping them just above the elbows, places them on the flexed head and neck. Holding tight to the head, he raises his arms and head simultaneously until his body is in the vertical position. This position places the shoulders and scapula posteriorly. As deep a breath as possible is necessary to lessen the exposure. It is very important that the tube be placed seven feet or more from the film since the aorta, for instance, is about five inches from the film.

The author discusses the value of this position in cases of foreign body, abscess, aneurysm, aortitis, aortic arteriosclerosis, and the differential diagnosis of pericardial effusion and acute dilatation of the heart, and believes this to be of great value in pathology of the base of either lung. The enlarged thymus should always be studied in the lateral position for evidence of compression and displacement of the trachea.

C. H. DEWITT, M.D.

**Subacute and Chronic Pulmonary Infections Commonly Mistaken for Pulmonary Tuberculosis.** Hugh J. Morgan, *Am. Rev. Tuberc.*, November, 1930, XXII, 491.

The writer confines his discussion to three diseases commonly met with, *viz.*: chronic bronchitis, subacute or chronic bronchopneumonia, and bronchiectasis. He states that records from Trudeau Sanatorium (1916-1923)

show that 75 per cent of the cases applying for treatment, found to be non-tuberculous, were cases of chronic bronchitis and chronic bronchopneumonia. No clean-cut differential points are given in the discussion of diagnosis from history and physical signs. Under chronic bronchopneumonia, he says the X-ray findings are points of great diagnostic importance, and under bronchiectasis, that X-ray examinations are diagnostic in the majority of cases.

The great value of the article lies in the signal which it sounds for care and the avoidance of hastily pronouncing the non-tuberculous, tuberculous.

S. C. BARROW, M.D.

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**Fibrin Bodies in Artificial Pneumothorax Cavities or Pleural Mouse.** H. V. Morlock and Franklin G. Wood. *British Jour. Radiol.*, November, 1930, III, 515.

Three cases of fibrin bodies observed in the pleural cavity, following artificial pneumothorax, are reported in some detail. In two of the cases an effusion preceded the appearance of the fibrin body, and in the third an effusion may have previously existed, although this was not definitely proven. The authors believe the theory of formation of fibrin bodies around a nidus of a fibrin flake or particle to be more probable than from the deposition of blood fibrin, following a traumatic hemorrhage of an intercostal artery. One case had been studied over a period of four years and the only change noted was a slight reduction in the size of the body. In most instances, change in position of the fibrin body could be demonstrated, hence the name "pleural mouse."

J. E. HABBE, M.D.

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**Bronchiectasis: An Analysis of 51 Cases.** W. W. Priddle. *New York St. Jour. Med.*, Sept. 15, 1930, XXX, 1077.

Bronchiectasis was diagnosed in 7.1 per cent of all cases in the adult medical wards of the Buffalo City Hospital. Lemon has found that 4 per cent of all children admitted to the Mayo Clinic have bronchiectasis. In the group re-

ported upon, incidence is greatest between 40 and 60 years of age, the onset occurring before the age of 20 in 21.5 per cent. Males were affected 4.1 times as frequently as females. Pulmonary infection in childhood is connected with bronchiectasis in a large percentage of cases. There was wide variation in the type of lesion found in the bronchus and surrounding lung parenchyma. Lesions were usually basal and more frequently on the left.

Roentgenography, as in any chest condition, was a real aid, but only in conjunction with clinical findings. In this series the X-ray department made a positive diagnosis in 64 per cent of the cases from plain films. The absolute diagnosis can be made only by the use of iodized oil injections, which give an accurate picture of the nature and extent of the lesion. This procedure should be used, however, only after other methods have been carefully considered. In 47 cases out of 51, clinical diagnosis was made by the history and physical findings alone.

W. W. WATKINS, M.D.

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**Localized Pneumothoraces as a Cause of Annular Shadows in Roentgenograms of the Chest.** W. P. Warner. *Am. Rev. Tuberc.*, November, 1930, XXII, 531.

This article is a complete clinical history, with X-ray findings and postmortem study, of a patient whose chest showed two large annular shadows, diagnosed by the radiologist as localized pneumothoraces, and so proven at postmortem. The author states that this is the only case found in the literature in which annular shadows resembling cavities, diagnosed as localized pneumothoraces, have been proven at autopsy. A very thorough review of the opinions, theories, and findings of the many who have written on the subject is given, making a valuable reference table for those interested in the question, "What are annular shadows?" The study of this case unfortunately does not determine the content of these cavities, or disprove a positive air connection with the lung, owing to accompanying pathology.

The report is a valuable one and should be studied carefully, along with the references,

by all roentgenologists engaged in chest examinations.

S. C. BARROW, M.D.

**The Normal and Pathologic Interlobar Fissure in the Roentgenogram.** I. G. Brdiczka and G. Wolf. *Röntgenpraxis*, Nov. 15, 1930, II, 1014.

The normal interlobar pleura may be demonstrated on an X-ray film. It presents itself as a very thin hair-line caused, in most cases, by the folding of pleura over the edge of the lung rather than by the projection of the interlobar pleura itself. The fine line is found in about 40 per cent of normal cases. Moderate thickening of the line indicates an old pleuritic process while a markedly thickened line proves the presence of interlobar adhesions.

H. W. HEFKE, M.D.

**"Pleural Rings" or Annular Shadows in the Lungs.** William Mitchell. *British Jour. Radiol.*, October, 1930, III, 446.

The author at once excludes ordinary tuberculous cavities and discusses those remaining annular shadows so puzzling to most radiologists. He prefers the term "air cysts," and believes that they almost always represent air spaces within the lung, produced by perforation of a small bronchus, with escape of air into the connective tissues in the form of a single bubble of air. If there is a ball-valve action between the bronchus and the air space, allowing ingress only of air into the "air cyst," then there may be a rapid increase in the size of the annular shadow. If, on the other hand, the point of perforation is healed over, then the imprisoned air may be quickly absorbed, with rapid decrease in size of the shadow. The author believes these air cyst shadows to be pathognomonic of tuberculosis, even in the absence of pulmonary fibrosis.

J. E. HABBE, M.D.

**X-ray Diagnosis.** Kenneth D. A. Allen. *Colorado Med.*, November, 1930, XXVII, 424.

This short paper is part of a symposium on atelectasis, and describes the diagnostic rôle

played by the X-ray in post-operative chest complications, with special reference to atelectasis. The X-ray plays its part in the following: (1) determining the behavior of the diaphragm, by films taken in expiration or inspiration,—or by fluoroscopy; (2) by determining the X-ray signs of atelectasis, and the type of lesion. The X-ray signs of atelectasis are (a) the displacement of the heart, mediastinum, and sometimes the tracheal shadows toward the affected side; (b) high diaphragm on the affected side; (c) decreased radiolucence of the atelectatic area; (d) increased radiolucence on the opposite side; (e) narrowing of the rib spaces; (f) affected lung curves toward the spine, while the opposite lung curves away from the spine; (g) heart moves toward the affected side in inspiration; (h) restriction of the diaphragm on the affected side. Atelectasis may be massive or localized. The localized type is not as clear-cut and requires close co-operation between the members of a medical team to make an accurate diagnosis.

W. W. WATKINS, M.D.

**Our Growing Dependence on the X-ray.** Editorial. *Canadian Med. Assn. Jour.*, October, 1930, XXIII, 563.

This editorial sums up rather well the changing attitude of the profession in general toward the radiologist. Quoting a speaker at the British Medical Society meeting in Australia, who, in discussing the value of radiology in the diagnosis of diseases of the chest, referred to the "physician with a guarded admiration for the radiologist, and the radiologist with no admiration for the physician," the Editor indicates that, while this is not the average viewpoint, it does reflect to some extent the stages through which medical opinion has passed or is passing, with regard to the place of the X-ray in the diagnosis of chest disease.

The Editor quotes from such "guarded admirers" of the radiologist as Cabot in his "Physical Diagnosis," and Morriston Davies and Sir Thomas Horder. Cabot is quoted as follows, "In incipient tuberculosis the X-ray as often leads us wrong, as right." Davies

says, "Radiology has helped to confuse us"; while Horder refers to the "bastard pathology" of the radiologist.

But the radiologist has his turn. Dr. Gerald Webb says, "Roentgen examination is the only method available for detecting early pulmonary tuberculosis." Dr. J. H. Fales is quoted: "The roentgen ray is the most important means of determining the existing pathological condition of the lungs."

With this latter viewpoint the Editor is in accord when he writes, "Where is the hospital which cannot show radiographs of pulmonary cavities whose presence had at best been only hinted at in the physical examination, but not diagnosed; or of foreign objects in the lung whose manifestations had for years been translated as those of tuberculosis?"

The Editor sums up the proper relation between the radiologist and the clinician as one of "co-operation." Each is supreme in his field, and the work of each should be the complement of that of the other, with resulting fixation of diagnosis. While the X-ray often provides information with an accuracy to which the physical examination cannot attain, it must not be depended on as a short-cut. It is an added source of information, which may confirm, correct, or amplify a diagnosis, or may fail to do any of these things.

L. J. CARTER, M.D.

**Early X-ray—Early Diagnosis.** William B. Davidson. *New England Jour. Med.*, Oct. 30, 1930, CCIII, 860.

Without early X-ray, the diagnosis of an early lesion of tuberculosis cannot be made. Especially is the early X-ray examination important in the childhood type of tuberculosis, not forgetting that the adult can have the childhood type. In a differential diagnosis the X-ray examination is indispensable. The author's technic, which is not essentially different from the usual technic, is described. He sees no advantage in extra-rapid exposure. Stereoscopic films have not been found to be more valuable than flat films, although the oblique or lateral views of the chest are recommended. Fluoroscopic examination should

be used as an adjunct. The classification of McPhedran is followed in the childhood type.

(*Abstractor's note:* It is refreshing to find a writer who is not afraid to say that the flat film is usually as useful as the stereoscopic film. It is believed that many radiologists have this view, and practise it, though the common expression, "excellent stereoscopic chest films are essential," bluffs them.)

W. W. WATKINS, M.D.

**Diagnosis and Treatment of Non-tuberculous Suppurative Lung Lesions.** James H. Stygall. *Jour. Indiana St. Med. Assn.*, November, 1930, XXIII, 526.

Our conception of lung suppurations has changed considerably in the last fifteen or twenty years, principally because of the use of the X-ray, lipiodol, and the bronchoscope. There are three common types of lung sup-puration—and they may be co-existent—namely, bronchiectasis, empyema with bronchial fistula, and lung abscess. Bronchiectasis is frequently undiagnosed, and unaided X-ray examination may be of little value, but by outlining the bronchial tree with lipiodol, the diagnosis is quickly made by the use of the X-ray film or under the fluoroscope. In lung abscess the physical signs are often negligible and at best depend on the proximity of the abscess to the periphery. The physical examination cannot be depended on entirely and should always be supplemented by the X-ray.

W. W. WATKINS, M.D.

**The Limitations of the Roentgenologic Diagnosis of Diseases of the Thorax.** Ernst Lachmann. *Röntgenpraxis*, Sept. 1, 1930, II, 769.

This article endeavors to show how seldom the roentgenologic symptoms of a chest disease are absolutely pathognomonic, and in which cases the anatomical changes are not demonstrable by means of the roentgen ray. The author's own experience and the opinion of other authors quoted from the literature make a very instructive essay on the limitations of the roentgenologic chest diagnosis. Although the roentgen examination is prob-

ably the most valuable means of diagnosis to the clinician, it should be closely associated with other diagnostic methods.

H. W. HEFKE, M.D.

**Silicosis.** T. H. Belt. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 802.

Silicosis is a purely industrial disease, affecting the lungs of persons whose occupations expose them over long periods to the dust of hard rock. The disease has received a great deal of attention in Africa, where, for many years, it has been a serious problem in the mining industries. Only within the past six years has the disease received serious attention in Canada, but in the Province of Ontario it is now recognized as a compensable form of disability.

Silicosis is characterized by extreme chronicity. It runs entirely to fibrosis of the lungs, and, while not fatal in itself, renders the victim particularly vulnerable to pulmonary infections. The majority of sufferers from silicosis eventually develop tuberculosis of the lungs, and the combination almost invariably proves fatal. In the presence of silica, the tuberculous infection runs wild, but the reason for this is unknown. Numerous theories of an explanatory nature are enumerated by the author.

L. J. CARTER, M.D.

**Mediastinal Pleural Effusion: A Roentgenologic Study.** Jacob Sagel and Leo G. Rigler. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1930, XXIV, 225.

The author states that mediastinal effusion is not so infrequent as formerly believed, and is often overlooked clinically, due to difficulty in diagnosis. It is generally encapsulated but may rarely occur as a free pleural effusion and extend secondarily into the lateral pleural cavity. Anatomically, the mediastinal pleural cavity is divided into two parts, an anterior and a posterior, which are separated by the pulmonary ligament. Considering location there are four possible kinds of mediastinal pleural effusion: (1) that in the anterior space on one side; (2) that in the posterior

space on one side; (3) the bilateral type, and (4) the so-called "saddle type." Etiologically there are two chief types: (1) the serous type, which is generally associated with pulmonary tuberculosis, and (2) the purulent type, which is usually pneumococcic or, rarely, streptococcic in origin. The purulent type generally follows pneumonia and should be sought for when prompt return to normal does not occur, after the usual period of illness.

As to the technic of examination, both roentgenoscopic and roentgenographic methods are used. The characteristic roentgen finding is a triangular shadow on either side of, and continuous with, the median shadow, from which it cannot be separated regardless of the position in which the patient is placed. It may displace the adjacent part of the lung or heart, usually the latter, to the opposite side. No cardiac pulsation is visible in this abnormal shadow. In some cases of posterior mediastinal involvement typical symptoms are produced, due to pressure on structures in the mediastinum. In the series of 15 cases cited, the posterior type predominated, recovery occurring in all but one case. Six were empyemas in the posterior space and were proved by thoracentesis. The article is well illustrated.

J. E. HABBE, M.D.

## CHEST (GENERAL)

**Bronchomycosis: Report of Two Cases.** William Royal Stokes, Edgar F. Kiser, and William H. Smith. *Jour. Am. Med. Assn.*, July 5, 1930, XCV, 14.

The etiologic relationship of certain forms of budding fungi included under the general name of *Endomyces* has been described by Castellani in calling attention to chronic bronchial infections in which tubercle bacilli in the sputum were never demonstrated. Such sputum, however, constantly contained various yeast-like organisms, which he divided into several groups.

Two cases are reported in which extensive chronic interstitial fibrosis existed and tubercle bacilli were not demonstrated in the sputum. A form of yeast was obtained in both;

which in morphology and cultural characteristics resembled *Monilia albicans* as given in Castellani's table, with one exception. This organism, injected into white rats, produced a pathologic condition similar to that produced by the tubercle bacillus, but these lesions did not show any tendency to spread through the internal viscera, and remained either as local processes or as scattered nodules on the serous surfaces.

Other observations showed this single exception to Castellani's grouping, and seemed to classify the organism as *Monilia albicans*. The isolation of these fungi from the sputum is, of course, no proof that they have produced the clinical conditions described. The repeated absence of tubercle bacilli and of other organisms suggests an etiologic relationship.

CHARLES G. SUTHERLAND, M.D.

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**Post-operative Pulmonary Hypoventilation.** Richard H. Overholt. Jour. Am. Med. Assn., Nov. 15, 1930, XCV, 1484.

Variations from the normal and physiologic conditions below the diaphragm, which occur after laparotomy and their effect on the position and activity of the diaphragm, indicate that pulmonary hypoventilation exists for a variable time after operation. A routine study of the chests of patients before and after upper abdominal operations showed a 75 per cent diminution of chest expansion after operation. The thoracic circumference became greater after operation. The observations indicated that free, normal respiratory activity is interfered with after the abdomen has been opened. Roentgenograms showed the superior-inferior diameter of the thorax to be greatly diminished in the post-operative films because of a marked elevation of the diaphragm. Fluoroscopic observation showed a 33 to 50 per cent reduction in diaphragmatic excursion after operation. Anything approaching physiologic aeration of a greater portion of the lower lobes during inspiration is impossible because of the position of the diaphragm and its diminished excursion. There would seem to be a definite mechanical disturbance to respiration as a consequence of

the admission of air into the peritoneal cavity. A study of the vital capacity of 218 patients was made before and after the performance of abdominal operations. Following operations on the upper abdomen, the vital capacity was reduced 64 per cent of the pre-operative or normal value. Following lower abdominal operations the average vital capacity was reduced 40 per cent of the normal value. Approximately a 15 per cent reduction in the vital capacity could be attributed to a tightly fitting abdominal binder applied post-operatively. When an ordinary surgical dressing of gauze and adhesive tape was applied, very little change in the vital capacity was noted.

The effect of pain in limiting respiration after operation was investigated by studying patients still under the influence of spinal anesthesia. From this study it would seem probable that a mechanical interference with respiration occurs at the time the abdomen is opened. This is confirmed by the experimental evidence. That pain is also an important factor cannot be denied. In cases in which symptoms of hypoventilation are very evident, treatments with carbon dioxide are given at regular intervals for a period of three or four days, post-operatively. Frequent turning and deep-breathing exercises should be resorted to early in every case.

The author suggests a post-operative procedure of having the anesthetist give carbon dioxide inhalations under positive pressure, as the abdomen is closed. Air in the abdominal cavity is displaced by a physiological solution of sodium chloride, which is removed by suction as the peritoneum is finally closed. A tightly fitting, many-tailed binder should not be used when there is pulmonary embarrassment. The free post-operative use of morphine should be encouraged.

C. G. SUTHERLAND, M.D.

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**Dust and Pulmonary Disease.** Albert E. Russell. Jour. Am. Med. Assn., Dec. 6, 1930, XCV, 1714.

The advances which have been made in all branches of industrial medicine have helped to center attention on dust and its effect on the health, as the number of the workers in dusty



plication. It may be of any extent, from involvement of very small portions of pulmonary parenchyma to a whole lung or both lungs. After reviewing a mass of literature of the past hundred years, including the papers by Coryllos and Birnbaum, Bowen, Van Allen and many others, the authors conclude that bronchial obstruction is the most important single factor in the production of atelectasis, and that with the relief of the obstruction the lung re-inflates. The pre-operative, operative, and post-operative factors, which may aid in the formation of this lesion, are discussed in detail.

Bronchoscopically, four types of findings in atelectasis were noted: (1) the presence of an obstructing plug or characteristic tenacious sputum; (2) a profuse purulent secretion; (3) no secretion in the bronchi; (4) one unusual case of local bronchial edema. The use of bronchoscopic aspiration in prophylaxis as well as in treatment was suggested, and the importance of applying the principles of intra-bronchial drainage in the posture of the patient, in combination with CO<sub>2</sub> inhalations, was discussed.

The uncomplicated post-operative lesion presents an excellent prognosis. All post-operative pulmonary complications, excluding embolic types, are not believed to be of the same nature. From clinical, X-ray, and bronchoscopic observations, the authors believe that there seems to be one type more like lobar pneumonia, and they discuss a case illustrated with roentgenograms. A large and most excellent bibliography is attached.

F. B. MANDEVILLE, M.D.

## CONTRAST MEDIA

**A New Method of Blood Vessel Visualization (Arteriography, Veinography, Angiography) *in Vivo*.** Makoto Saito, Kazunori Kamikawa, and H. Yanagizawa. *Am. Jour. Surg.*, November, 1930, X, 225.

The authors review the work that has been done in this line up to the present time, and describe their solution as a fine emulsion of iodized oil, originated by Professor Hattori

of the Tokio Imperial University. To prepare it protalbinacid was used. The preparation is a yellowish-white, slightly alkaline, isotonic emulsion. No hemolytic or rapid hemostatic action *in vivo* or *in vitro* was found. Each oil globule is smaller than a blood corpuscle.

This new contrast medium, called L'ombre, has given clear, satisfactory roentgenographic films. It has also been used in pyelography, myelography, and visualization of fistulæ and articular cavities. For pyelography it is especially valuable because of the low viscosity, the absence of irritation to the mucous membranes, and the strong radio-activity which insures very clear shadows.

The original article should be consulted for the technic in using this solution and for its preparation.

HOWARD P. DOUB, M.D.

**Roentgen Diagnosis of Synovial Adhesions.** Editorial. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1749.

Following fifteen years of patient experimentation, another unusual chemical adjunct to roentgen diagnosis seems to be available. With this new aid, altered permeability of synovial membranes can be determined, and accurate pictures secured of synovial adhesions. Demonstrations of abnormal synovial permeabilities were made about sixteen years ago by Dr. Henry Keller, orthopedic surgeon of the Neurological Hospital, New York, who injected easily diffusible dyes into joint cavities, and followed their subsequent excretion by the kidneys. Disodium salt of tetraiodo-orthosulphobenzoic acid is a non-toxic chemical substance readily excreted by the kidney, and of sufficient density to cast a distinct shadow on the X-ray film. This sodium salt is odorless, tasteless, and readily soluble in water, an 11.3 per cent solution being isotonic with human blood. The isotonic solution is non-irritating when instilled into the conjunctival sac of the human eye. Injection into laboratory animals does not cause local irritation. Intravenous injections are well borne by animals and the injected drug is rapidly excreted by the kidneys. Kidney function is

not impaired. With ordinary concentrations, no depression is demonstrable with isolated smooth muscles. Albino rats, previously trained in a circular maze, do not show impairment of memory on administration of the new drug or alteration in neuromuscular control. Injected into joint cavities of dogs, the new compound gives sharply defined X-ray shadows of joint cavities.

C. G. SUTHERLAND, M.D.

**Uroselectan in the Demonstration of Blood Vessels (Vasography) and Especially of Varicosities.** Max Ratschow. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 37.

For successful roentgenologic demonstration of the blood vessels, four demands have to be met by the contrast medium to be employed: It must not harm the interna of the vessels, nor produce disturbance of circulation or affection of the organism, but it should be sufficiently radiopaque in high dilution. All opaque oils produce fatty embolism and bronchopneumonia. Strontium bromate produces thrombosis of vessels.

Uroselectan proved to be a very satisfactory contrast medium, and, as demonstrated in a series of reproductions, permitted of excellent visualization of veins and especially of varicosities.

HANS A. JARRE, M.D.

**Uterosalingography in General Practice: with Case Reports.** J. Martin Johnson. *Wisconsin Med. Jour.*, September, 1930, XXIX, 497.

The author's procedure is preliminary and operative. In the preliminary stage, a careful history is taken and complete physical examination made; this latter includes determination of the patency of the cervix, and dilatation of the canal is made. Following this, the patient may be taken or sent to the X-ray laboratory, the co-operation of an experienced roentgenologist being deemed essential. With the patient on a table equipped with a Bucky diaphragm, by means of the Pressometer, lipiodol is injected. The fluoroscope may be used to follow the injection, if desired.

After four or five c.c. have been injected, the first film is made and the patient is allowed to flex or extend her legs, though without disturbing the nozzle in the uterus. After developing the first film and noting the amount of oil injected, a second injection is made. A total of 10 c.c. should be sufficient in the majority of cases. This procedure definitely outlines the uterus and tubes, and localizes the point of obstruction if the tubes are not patent. The procedure is harmless and may be readily accomplished by the physician who adheres to fundamental principles.

W. W. WATKINS, M.D.

### DIAPHRAGMATIC HERNIA (DIAGNOSIS)

**Progress in the Roentgenologic Diagnosis of Diaphragmatic Hernia.** Alexander B. Moore and B. R. Kirklin. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1966.

A vast and growing literature on diaphragmatic hernia attests the keen interest in this condition. From experience it is evident that diaphragmatic hernia is not merely a pathologic oddity, but a lesion which should be taken into practical account and given higher rank among the possibilities to be canvassed at examination. Recent publications emphasize the congenital factor, whereas in earlier days the acquired form, principally that resulting from violent crushing injury, was stressed. An increase of intra-abdominal pressure is often doubtless the cause of hernia, congenital gaping of the hiatus esophageus or other foramina, or developmental weaknesses in other portions of the diaphragm, usually being a significant predisposing element. An interesting variety is that in which the esophagus is congenitally shortened. When the entire stomach lies above a normally developed diaphragm, some prefer the designation "thoracic stomach," and classify it apart from the hernias.

Case reports, over the last five years, deal with traumatic hernias through breaches in various parts of the diaphragm, parasternal and other hernias, congenital or acquired, all differing in details but fundamentally alike in their diagnostic problems. The aggregate of

new reports tends to confirm the accepted fact that the stomach is most frequently implicated in the hernia and is followed by the colon, small bowel, omentum, spleen, pancreas, and liver, singly or in varying combinations. Of all the cases now on record, the vast majority were revealed by the roentgen ray. Obviously, then, the roentgenologist has a virtually clear field and a proportionate responsibility for this diagnosis. The chief obstacle to the diagnosis of diaphragmatic hernia is the neglect to look for it. The examiner is often obliged not only to consider all details with extraordinary care, but also to resort to special technics. Unless the hernia is extremely small or is reduced spontaneously at the moment, thoracic changes will be evident in the chest roentgenogram. Any deviation in the terminal course of the esophagus or retarded entrance of the barium into the stomach, should at least suggest the thought of hernia. Distortion of the stomach in hernia of any type is variable in degree and configuration. Rarely, as in a congenital absence of the left diaphragmatic arch or in a gross traumatic hernia, little distortion occurs. Most often, however, the stomach is only partially herniated and hour-glass deformity results rather constantly. Since the fundamental distinguishing mark of hernia is the supradiaphragmatic situation of abdominal organs it is necessary, although sometimes difficult, to trace the outline of the arches. Often the arch is irregular, or sinuous, or angulated at the point of rupture, or the margins of the breach may form a visible collar. Respiratory movements of the arch may be normal, diminished, absent, or reversed, depending on the size of the hernia and the extent of fixation by adhesions. Completing the picture are displacement of the heart, if the hernia is large, and shading of the lung, in proportion to the amount of compression.

Ordinary technic is often inadequate and must be supplemented by special methods. The advantages of the lateral view have been dwelt upon. The prone position, with manual pressure on the abdomen, has revealed hernias not demonstrable otherwise. Deep inspiration by the patient, or bending over, while in the standing position, or strong manual pres-

sure over the abdomen may cause re-appearance of a spontaneously reduced hernia. Examination of the stomach for diaphragmatic hernia is not decisive unless both the erect and recumbent postures are employed, and careful search, by the special methods outlined, is made. Diaphragmatic hernia cannot be absolutely excluded without an examination of the colon with the barium enema. Serial observations of the ingested opaque meal may be advantageous or necessary in establishing the diagnosis of the rare cases in which the small bowel alone is implicated. Cardio-esophageal relaxation, characterized by dilatation of the epicardia and ready reflux of the barium into the esophagus, might be confounded with hernia. Eventration is perhaps the most deceptive simulant of hernia. In eventration, the upper level of the barium in the stomach always coincides with the esophageal opening when the patient is erect, whereas, in hernia, the upper level of the gastric content is likely to be above the plane of the esophageal aperture.

CHARLES G. SUTHERLAND, M.D.

**A Very Large Diaphragmatic Hernia.** P. Eichler. *Röntgenpraxis*, Aug. 1, 1930, II, 712.

A very large diaphragmatic post-traumatic hernia was found in a patient in whom the stomach and colon almost filled the entire left chest, reaching to the level of the clavicle. The examination of the chest pointed to a seropneumothorax, and only during the examination of the stomach, by means of a barium meal, could the exact diagnosis be made.

H. W. HEFKE, M.D.

#### DOSAGE

**The Effect of Graded Doses of Roentgen Rays on the Mitosis in *Vicia faba equina*.** O. Jüngling and H. Langendorff. *Strahlentherapie*, 1930, XXXVIII, 1.

The authors studied the mitosis in roots of *Vicia faba equina* under normal conditions. The curves, plotted with the number of mitoses as ordinate and the time as abscissa, showed a certain rhythm. Exposure to roent-

gen rays in doses of 40, 50, 175, 420, and 550 r changed the curves materially. Small doses which did not produce macroscopic nor microscopic changes accelerated the course of the mitosis. Large doses producing definite injuries caused the aforementioned change in the slope and shape of the mitotic curves, as compared with the untreated controls. The principal effect consisted of an increase of the time between two mitotic cycles. For details of the changes a study of the curves is recommended.

ERNST A. POHLE, M.D., Ph.D.

**A Contribution to Dosimetry with the Sabouraud-Noiré Tablet.** Karl Hoede. *Strahlentherapie*, 1930, XXXVIII, 173.

The author compared the Sabouraud-Noiré Tablet at potentials of 75 K.V., and 120 K.V., unfiltered, 0.5, 1.0, and 4.0 mm. Al, with a Hammer dosimeter. He found that, in addition to the sources of error demonstrated by previous investigators, there is to be added the absorption by the tablet holder. Depending on the penetration of the radiation, this error may amount to as high as 50 per cent.

ERNST A. POHLE, M.D., Ph.D.

**The Necessity of Exact Dosage Data in Grenz-ray Therapy.** O. Gfrörer and Heinz Berger. *Strahlentherapie*, 1930, XXXVIII, 184.

Emphasis is laid upon the fact that the half value layer is not a good quality factor in Grenz-ray therapy. It is essential to indicate the peak kilovoltage, the tube current, the window-to-skin distance, and the output in r-units.

ERNST A. POHLE, M.D., Ph.D.

**A Biological Calibration of an X-ray Dosimeter.** Charles Packard. *Jour. Cancer Research*, March, 1930, XIV, 134.

The author calibrated a Victoreen dosimeter, 1928 model, by a biological method. The eggs of the *Drosophila* were radiated and the proportion which hatched, following radiation, was determined. It has been found that when these eggs are subjected to a radiation of a

definite number of r-units, a certain percentage hatch. This is independent of the quality or wave length of the X-radiation employed. A curve was obtained showing the percentage of eggs hatching after various doses measured in r-units by a large, open ionization chamber. This curve is not accurate for very small or very large doses. The dosimeter was tested and calibrated against the curve at 60, 100, 150, and 200 kilovolts. The first three were obtained on a Wappler Diex (thermionic rectification). The test with 200 K.V. was made with a mechanically rectified outfit.

The author found that the dosimeter records the dosages correctly, according to this method, when the voltages range from 100 to 200 kilovolts. Under 100 K.V., the full intensity was not registered, being about 13 per cent too low at 60 kilovolts.

JOHN R. CARTY, M.D.

**The Reproductivity of the Roentgen Dose Unit.** Hermann Behnken and Robert Jaeger. *Strahlentherapie*, 1930, XXXVI, 778.

Reisner and Neeff have published the results of measurements (*Strahlentherapie*, XXXIV, 313) showing that apparently the calibrations of various ionization instruments in r-units do not agree well. The authors discuss this paper in detail and offer material demonstrating the fact that the r-unit is possible of reproduction within close limits if the measurements are conducted properly.

ERNST A. POHLE, M.D., Ph.D.

## FOREIGN BODIES

**Observation in Fifty Cases of Foreign Bodies in Air and Food Passages.** E. G. Gill. *Virginia Med. Monthly*, November, 1930, LVII, 516.

Forty-seven cases gave a history of having aspirated or swallowed a foreign body. Three cases did not have such a history. One of these had been treated for cough, pneumonia, and empyema before the X-ray showed a mattress tack in the right main bronchus. The second baby had been treated for five weeks for "colic" before the X-ray examination showed a large wire ring in the esophagus.

ite history of choking or  
by the parents of a child,  
or playing with objects, or-  
c, the case should be consid-  
ign body until proven other-  
gnostic method at our com-

W. W. WATKINS, M.D.

oth in the Left Lower  
id H. Ballon. Canadian  
r., December, 1930, XXIII,

report of a patient who had  
ted under general anesthesia.  
f the anesthetic he coughed  
d told the dentist he had  
ing, because he felt a tight-  
Two days later he became  
ptoms of lung abscess. The  
n showed a tooth in the left  
s and ether anesthesia the  
ed. Recovery was unevent-

L. J. CARTER, M.D.

ocular Foreign Bodies: Re-  
arton J. Powell. California  
d., October, 1930, XXXIII,

g foreign bodies in the eye  
tolerance of the eye to many  
hor reports several cases in  
lies were present for a num-

marizes as follows: "There  
ent use of the magnet and  
to detect the presence of a  
also as a safeguard against  
of malpractice and neglect.  
intelligent use of that most  
ion apparatus, perfected by  
master, the late William M.

F. B. SHELDON, M.D.

Smith. Southern Med. Jour., October, 1930,  
XXIII, 929.

This author reports his experience in a  
study of 150 patients by the use of dye intra-  
venously. He first used the dye by the oral  
method, with tablets and capsules, but the re-  
sults were so unsatisfactory that the intrave-  
nous technic was adopted, and since the im-  
provements in oral technic he has not seen  
fit to return to the former method. Of the  
150 patients, 94 were considered as pathologi-  
cal. Fifty have been operated upon, and a  
diagnosis was confirmed in 48, so that the pre-  
operative diagnosis has been confirmed in 96  
per cent of the cases. The two errors in di-  
agnosis were both found to have duodenal ul-  
cers, and the failure of the gall bladders to  
empty is believed to have been due to pyloro-  
spasm, with prolonged gastric retention of the  
fat meals. The dye is given at the office at  
9 A. M., and films are made at five hours and  
again at eight hours, with a fatty meal  
between.

W. W. WATKINS, M.D.

Cholecystography: An Analysis after Six  
and One-half Years' Application. Sherwood  
Moore. Jour. Am. Med. Assn., Dec. 27,  
1930, XCV, 1957.

The underlying physiologic and radiologic  
principles of cholecystography have altered lit-  
tle since 1923. There have been certain changes  
in views or detail of methods and other points.  
The author discusses these and epitomizes the  
sum of the experience of himself and his co-  
workers.

Phentetiothalein sodium-N.N.R. (phenol-  
tetraiodophthalein sodium) is preferred. In  
addition to being an effective test of liver  
function, this dye is less toxic than others. It  
produces a more desirable cholecystogram,  
with a smaller quantity of dye. The use of  
substances other than the halogenated phe-  
nolphthaleins for visualizing the gall bladder  
have not proved practical in their hands. In  
general, whatever the dye employed in chol-  
ecystography, accuracy demands that it be

given intravenously, for a known quantity of the substance must reach the circulation if the resultant gall-bladder image is to be exactly evaluated. The routine of administration is given in detail. Oral administration, in their hands, has been employed for diagnostic purposes only in special cases, in which the symptoms are insufficient to warrant the intravenous procedure, or occasionally in an obese subject when there is difficulty in finding a vein suitable for puncture. Their experience has been that more subjective discomfort (usually in the alimentary tract) follows the oral than the intravenous administration of the dye. Vomiting and diarrhea raise a doubt as to whether or not sufficient dye is absorbed from the alimentary tract to give dependable data as to its concentration in the gall bladder. Phentetiothalein sodium is valueless as a test of liver function when given orally, because the quantity of dye absorbed is unknown. Cholecystographic estimation of the condition of the gall bladder is based on the fact that the normal organ receives the dye, concentrates it, alters in size (or shape), and finally evacuates its contents. This sequence can be assured only if the organ is at rest during the foregoing cycle. A diseased gall bladder has its functions interfered with, and the departure from normal behavior is proportional to the degree of impairment of the organ. The test reveals anatomic changes only coincidentally or inferentially.

The fat meal is not used for testing the emptying capacity of the gall bladder, experience indicating that if the organ is visualized it will empty itself; also, that any impairment of its wall that might affect the organ's ability to void its contents would have as concomitants obvious deviation from the normal cholecystographic behavior. In disease of the liver, of such extent that the gall-bladder function is affected, there would scarcely be occasion to attempt cholecystography, as the diagnosis would probably be obvious. Acute disease of the biliary tract is a contra-indication to cholecystography. In pericholecystitis of intrinsic origin, there is a total absence of the concentrating function of the gall bladder. In pericholecystitis of extrinsic origin, there is an approximately normal concentrating

function of the gall bladder, with rarely demonstrable deformity or fixation of the organ. Pericholecystitis is dealt with at length for the reason that it has many pitfalls in cholecystographic interpretation.

There is a type of stone found in the gall bladder with normal function which is not otherwise discernible, the so-called negative or cholesterol stone. Because of the experience with calcified stones, radiographic search for them precedes cholecystography. Low in the scale of accuracy of pre-operative diagnosis is the cholecystogram which reveals a gall bladder with a deficiency of the concentrating function, having a "thin" or "faint" shadow. The persistence of the shadow beyond a twenty-four-hour period is so dependent on food intake and activity that its diagnostic importance has dwindled virtually to the vanishing point. The gall bladder that is promptly visualized, concentrates the dye, and empties without delay in the oral method is a normal gall bladder. Any deviation from this behavior, when the oral test is employed, should be followed by an intravenous test.

CHARLES G. SUTHERLAND, M.D.

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**Biliary Tract Visualization with Radiopaque Oils.** Richard H. Overholt. *Surg., Gynec. and Obst.*, January, 1931, LII, 92.

The use of radiopaque solutions to define the biliary ducts after a drainage operation has proved of sufficient value during the past year to warrant the publication of the results of such a procedure. The more limited the exploration at the time of operation the greater this uncertainty. A definite knowledge of the patency of the biliary duct system is required in the proper post-operative management of the case, such as the determination of the time for withdrawal of the T-tube, and in giving a prognosis as to the probability of a persisting biliary fistula. The determination of obstruction of the common duct before the T-tube is withdrawn is also important if a second operation is required, as the common duct is more easily located if the T-tube is left *in situ*.

There are various indirect ways of gaining

information about the condition of the common biliary duct after operation. However, in some patients these criteria are not reliable. During the second or third week after operation, the patient is placed on an adjustable fluoroscopic table. The gall-bladder drainage tube or common duct tube is then injected with the opaque material, under fluoroscopic control, the amount varying from 15 to 20 cubic centimeters, depending upon the manner in which the biliary system fills. No force is required to make the injection as the solution will practically run into the ducts by the force of gravity.

Campidol (iodized rapeseed oil) was found to be a safe and satisfactory visualizing medium. When a complete or partial obstruction of the common duct was noted, the drainage tube was clamped following the injection, and fluoroscopic examinations made at intervals over a period of from 30 to 40 minutes. In some a duodenal tube was passed, and a solution of magnesium sulphate was injected. In no instance was there an untoward result following the injection of the biliary system. In the patients in whom no obstruction to the emptying of the common duct existed, the campidol passed immediately through the duct and into the duodenum. At times the flow of the oil would be checked at the ampulla momentarily, during which interval, waves in the common duct seemed to sweep the oil toward the hepatic ducts, before it would enter the duodenum. In such cases, however, the hepatic ducts filled poorly and the common duct incompletely. Roentgenograms showed the opaque medium scattered in the upper jejunum. It is well, for this reason, to make a large enough exposure to include both upper quadrants of the abdomen.

When an obstruction existed in the common duct, this duct as well as the hepatic ducts promptly filled and were clearly visualized. The position, contour, and size of these ducts were clearly determined. Incomplete common duct obstruction in some cases was evidenced by a filling of the duct system, with only small expulsions of oil into the duodenum. When contraction waves were seen in the common duct, with obstruction present,

there was a tendency for the opaque medium to be forced higher in the hepatic ducts.

The injection of a cholecystostomy drain, with obstruction of the common duct, showed the gall bladder, cystic and hepatic ducts. If there was no obstruction, the gall bladder and ducts filled poorly and immediate entrance of the campidol into the duodenum was noted. This information was especially important as it was in such cases that exploration at the time of operation was unwise. In cases in which the common duct obstruction had existed for a long period of time, a dilatation of the hepatic ducts could be demonstrated. In the author's cases the degree of hepatic duct dilation corresponded closely to the degree of liver drainage as estimated by the biliary output, the change in the Van den Bergh reaction, and the duration of the convalescence.

D. S. CHILDS, M.D.

## GASTRO-INTESTINAL TRACT (DIAGNOSIS)

**On Great Gastric Retention and Dilatation of the Stomach in Cases of Gastroduodenal Ulcer and Cancer of the Stomach.** T. Klason. *Acta Radiologica*, 1930, XI, Fasc. 4, No. 62, p. 444.

The author analyzes his cases of gastroduodenal ulcer and gastric carcinoma seen in the past five years. Of 451 cases of ulcer, 258 were duodenal, and 193 were gastric. He found gastric retention in 11 per cent of the duodenal ulcers and in 5.7 per cent of the gastric ulcers. Of the 201 cases of gastric carcinoma, retention was found in 14.3 per cent, being, of course, most common in the antral lesions. The author calls attention to the fact that in obstructing carcinoma of the pyloric end of the stomach the tumor is better demonstrated at four hours than immediately after the barium meal.

M. J. GEYMAN, M.D.

**Acute Ulcerations of the Stomach in Children.** Benjamin Rice Shore. *Ann. Surg.*, August, 1930, XCII, 234.

A female infant, aged 22 months, had frequent vomiting for thirty-six hours. It died at operation, with an acute perforated ulcer-

tion of the stomach wall, the ulcer being situated on the posterior wall near the fundus of the stomach. There were no signs of chronic ulcer present. The markedly hemorrhagic edges of the necrotic area suggest that the primary lesion was one of hemorrhage, either from local injury, overdistention, or vascular thrombosis, and that gastric digestion in this area caused the perforation.

The etiology of acute ulcers is discussed. Congestion, embolism, thrombosis, vascular disease, direct injury to the mucosa, and nervous influences are considered.

F. B. MANDEVILLE, M.D.

**Gastric and Duodenal Ulcers.** L. O. Nordstrom. *Jour. Kansas Med. Soc.*, September, 1930, XXXI, 316.

The diagnosis of peptic ulcers in well developed and uncomplicated cases is comparatively easy, but in early cases and when complications cloud the picture, diagnosis is often most difficult. Roentgen-ray examinations are positively necessary for a correct diagnosis. Not only may a positive diagnosis of ulcer be made when a niche is present, but definite information as to the size, shape, position, and motility of the stomach, may be gained.

W. W. WATKINS, M.D.

**Contribution to the Knowledge of Ulcer of the Extra-bulbar Portion of the Duodenum.** Rodolfo Viviani. *La Radiologia Medica*, June, 1930, XVII, 698.

A survey of the contemporary literature discloses very few references to ulcers of the extra-bulbar portion of the duodenum. The author reports the radiological examinations of four cases. The main difficulty encountered in the clinical diagnosis of this lesion is the lack of characteristic symptoms which would indicate its exact position. The radiological manifestations are, instead, fairly well determined. The author, after a detailed study, is led to the following conclusions:

(a) The positive signs of the ulcer are: (1) ulcer niche; (2) general deformity of the duodenum, consisting of a stenosis around the orifice of the niche and of a disappearance of the shadows of the duodenal ridges; (3) the

presence of a spasm in front of the image of the ulcer.

(b) A diverticular image of the extra-bulbar portion of the duodenum may be interpreted as an ulcer and differentiated from other affections when a complete study is made of the alterations of the walls of the intestines.

(c) Although the niche is the most significant of the radiological signs, other anomalies of the duodenum may disclose peculiar characteristics of an ulcerative process. In doubtful cases, however, a positive diagnosis must be supported by clinical symptoms.

(d) The analogies existing in the radiological images of the alterations of the different portions of the gastro-enteric tube, in which an ulcer may be located, show how the intestinal canal responds, with constant and peculiar pictures, to the anatomic condition of the area affected.

(e) The fact that an ulcer of this portion of the duodenum is not so rare an occurrence as is frequently thought ought to lead the radiologist to an accurate and systematic study of the entire duodenal area.

L. MARINELLI.

**Peptic Ulcers: Diagnosis and Treatment.** Philip King Brown. *California and Western Med.*, November, 1930, XXXIII, 804.

The author discusses the etiology, medical treatment, subjective symptoms, and particularly the value of the X-ray in diagnosis and treatment. When the X-ray reveals a typical deformity, with a six-hour retention, and there is a characteristic history of pain after food, with occult blood in a milk residue stool, the author believes it is foolish to say nothing is wrong. When, with a clinical and X-ray diagnosis of ulcer, the surgeon complains that he has failed to find the ulcer at operation, the case has not been properly studied or the operation properly conducted.

Retention, evidenced by distress, lack of appetite, loss of weight, nausea, vomiting, etc., and confirmed by the X-ray, does not necessarily call for surgery. Cleaning out such a stomach and the Lenhart diet will usually steadily reduce the retention. The author's plan is to re-check in twelve days, with grad-



ually increased diet. As much as a 50 per cent retention from ulcer has disappeared in that time. A few cases, not good operative risks, have had the rest and diet continued a month or even more; and he is gratified to find that it is worth while often enough to give it serious consideration.

F. B. SHELDON, M.D.

**Syphilis of the Stomach—A Study of Eight Cases.** John B. Fitts. *Ann. Int. Med.*, December, 1930, IV, 628.

During a period of eight years there were 35,000 patients admitted to the hospital, with eight cases of gastric syphilis.

The X-ray signs of gastric syphilis are as follows:

1. A concentric, symmetrical defect of the gastric lumen.
2. The stomach appears high, with narrowed lumen.
3. If the lesion is antral, it appears in a narrowed tubular effect.
4. If the lesion is of the hour-glass type, the isthmus of the hour-glass is elongated and dumbbell-like.
5. The pylorus may be gaping, or, less frequently, obstructive.
6. Six-hour residues are found only in the obstructive type.
7. The technical point of differentiation from carcinoma lies in the fact that the syphilitic lesion is symmetrical, while the carcinomatous is asymmetrical and irregular.

Syphilis may involve the stomach in three ways, namely, (1) diffuse syphilitic gastritis; (2) syphilitic ulcer; (3) gummatous infiltration. The symptoms present in gastric syphilis are pain, vomiting, loss of weight, positive Wassermann, and characteristic X-ray findings.

C. H. DEWITT, M.D.

**Psychogenic Factors in the Etiology of Ulcerative Colitis and Bloody Diarrhea.** Cecil D. Murray. *Am. Jour. Med. Sci.*, August, 1930, CLXXX, 239.

In this article, the author reviews a series of 12 cases of ulcerative colitis and bloody diarrhea, with special reference to psychogenic

factors in their etiology. He cites a number of cases in which there is a rather startling relation between the onset of the disease and the outbreak of emotional disturbance, the first mucus shreds or the first blood appearing in the stools at times of emotional stress. He gives complete histories of four cases in which this relation was most striking that tend to show how serious the physical condition may become in one or more of the following circumstances, namely: (1) if the emotional conflict is deep-seated or chronic or not easily settled; (2) if there is a specific organism, and, vague though it is, we must add, (3) if the individual is predisposed in some way by heredity, early training, general physical or nervous makeup, etc., to colon afflictions.

He compares this last to the fear component in cases of gastric ulcer, emphasized by Draper and McGraw (*Am. Jour. Med. Sci.*, 1927).

The outstanding trait in colitis patients besides fearfulness is their emotional immaturity, and in this respect they differ from the gastric ulcer individuals.

The author finds that mental conflicts concerned with marriage were more commonly found than other types of situations which might evoke anxiety. In each case, the patients faced their problems in an inadequate, infantile manner. He feels that if the pathologic process has not progressed too far, a thorough investigation into the patient's life and mental attitude may afford opportunity for much needed psychotherapy.

ROE J. MAIER, M.D.

**The Irritable Colon.** John Muir. *British Jour. Radiol.*, September, 1930, III, 391.

The author attempts to show that evidence of gastric irritation may be found not merely with such extrinsic causes as pathologic gall bladder, appendix, etc., but that the same finding may be co-existent with no extrinsic organic lesion, but only a similar state of irritation of the colon. Localized pylorospasm is considered more significant than generalized hypertonicity or hyperperistalsis, as regards colon irritability. The signs of irritable colon are given as follows: (1) tenderness distrib-

uted along the course of the colon, often accentuated over the middle of the transverse or over the descending portions; (2) exaggerated and irregular haustration or segmentation; (3) inconstant dilatation of the proximal colon, and (4) by enema study of hypermotility through certain segments, most often the pelvic and descending portions. The author urges caution in the interpretation of irritability of the colon, since there are such wide variations within normal limits, but at the same time calls attention to the extreme variability of the roentgen findings as the clue to absence of organic intrinsic lesions and the presence of irritability only.

J. E. HABBE, M.D.

**The Roentgenologic Demonstration of a Gastric Myoma.** Hans Gebhardt. *Röntgenpraxis*, Oct. 15, 1930, II, 913.

The diagnosis of benign tumors of the stomach has been greatly furthered by the roentgenologic examination, using small amounts of barium, and compression. It is possible to reach a diagnosis of a benign gastric tumor in quite a number of cases by this examination, especially if one observes the behavior of the surrounding mucosa. A case is described in detail which presented a definitely outlined, well circumscribed, round filling defect in the corpus of the stomach, with a normal mucosa surrounding it. Operation proved that this tumor was a myoma.

H. W. HEFKE, M.D.

**Radiological Diagnosis of Duodenal Ulcer.** Paolo Buisson, Marco Bermond, and Mario Buisson. *Minerva Medica*, April 14, 1930, I, 599.

The most reliable method to adopt for a diagnosis of duodenal ulcer is a series of radiographs. Fluoroscopy, while not entirely satisfactory, is superior to any clinical examination and is to be considered, in some cases, as a supplement to radiography.

The authors analyze the fluoroscopic factors (gastric hypertonia, Kreuzfuchs' sign, pyloric insufficiency, temporary spasm of the pyloric region, etc.) which may be noted in a case of

duodenal ulcer. They point out the inadequacy of such examination by discussing other gastric affections which would present the same fluoroscopic characteristics. Clinical examination and history are to be resorted to only when more factors of differentiation are needed because they cannot, by themselves, supply any definite criterion except for the most evident cases.

As for radiographic signs, it is advisable to consider two series. The first shows a pathological stage of the pyloro-duodenal region, but it cannot lead to an unquestionable diagnosis. It consists of such anomalies as eccentric position of the pylorus, with respect to the duodenal bulb, the pyloro-duodenal "dextro-fixation," and the bulbar ante-position *et similia*. The second series consists of the positive pathognomonic signs of duodenal ulcer, namely, the niche, the cicatricial deformation, Akerlund's pseudo-diverticulum, and the "enchoche" or "bulbous defect." The authors consider the persistency of the shape and position of these images as the most reliable factors, and illustrate their detailed discussion by reporting 21 cases (out of 300 studied), with an extensive radiographic repertoire.

L. MARINELLI.

**X-ray Examination in Acute Intussusception.** Einar Edberg. *Acta Radiologica*, 1930, XI, Fasc. 2, No. 60, p. 194.

For twenty years the author has been interested in intussusception, but only in the last two years has he employed the X-ray examination in selected cases. The higher the intussusception, the more difficult is the diagnosis by opaque enema. The author's experience is that in pure ileal intussusception it is very hard to make any other pre-operative diagnosis than intestinal obstruction. He has found Meckel's diverticulum involved in a number of these cases.

Intussusception of the colon was the first form to be described from the roentgenographic viewpoint. Edberg feels the X-ray examination is of no great value in acute intussusception of the colon, but of much usefulness in chronic colic intussusception in adults. Seventy-five per cent of all intussus-

ceptions occur in children, and 75 per cent of these are in the vicinity of the ileocecal junction. The author describes two main types: (1) the ordinary ileocecal intussusception and (2) a variety which he terms the ileo-ileocolic. At X-ray examination one sees the head of the intussusceptum and the central column of barium mixture filling the outer column as a piston fills the barrel of a syringe. In ileocecal intussusception there is ordinarily a shell-shaped filling defect in the opaque column in the region of the invagination. The head of the intussusceptum may pass far into the colon. The colon distal to the lesion is usually tubular, with decreased haustrations. There is likely to be comparatively little accumulation of gas in the small intestine, even though ileus has existed for some time.

In ileo-ileocolic intussusception, the primary invagination occurs in a loop of the terminal ileum, and at first only the small intestine is involved. Usually this type of intussusception does not pass as far into the colon as the common ileocecal form. The invaginated part has more room than in the ileocecal type, and the peripheral portion looks like a stocking drawn over the swollen invagination. The opaque enema can pass between the middle and outer cylinders of intestine. The haustrations are small. The lower colon is tubular, but near the intussusception one often sees a beautiful relief of the mucous surface of the bowel. As a rule, there is more gas in the small intestine than in the ileocecal intussusception and meteorism appears much earlier.

The author states that he has compared the fluoroscopic appearance, the roentgenograms, and the operative findings in his cases, and that as a result he feels that a differentiation between ileocecal and ileo-ileocolic intussusception can be made by the X-ray examination. The importance of this is better understood in view of the fact that early ileocecal intussusception may often be reduced mechanically, whereas the ileo-ileocolic type should be operated upon immediately.

The author has been interested in attempts at reduction by barium enema. He has seen three cases of early ileocecal intussusception rapidly and completely reduced by the opaque

enema. One of these patients was explored 24 hours after the reduction, and characteristic residual swelling and edema were found in the cecum. Another case showed almost instantaneous reduction of an intussusception that screen examination had shown to have reached the hepatic flexure; when symptoms recurred within a week, an operation was performed which disclosed a diverticulum in the terminal ileum and fixation of both the cecum and appendix. The fixation of the cecum prevented cecal invagination but permitted ready prolapse of the diverticulum into the colon. Cases of this sort may allow invagination of the ileum into the colon for a considerable distance; reduction is usually easy. Edberg has seen partial reductions under the screen which were not permanent.

At the end of the article the author reports 11 cases, 9 of which are under one year of age. Only one of the patients succumbed. The clinical history, roentgenograms, and operative findings are given in each instance. He concludes as follows:

(1) Simple ileocecal intussusception on roentgenograms shows a wide, shell-shaped filling defect in the barium enema at the site of the lesion, and only a small amount of gas in the small intestine even after a relatively long illness.

(2) Ileo-ileocolic intussusception shows the opaque medium in a thin layer about the intussusceptum, and gives the impression of an irregular, spiral filling defect in the barium column. The mucosal folds in the wall of the colon are visible. There is more gas in the small intestine than in the ileocecal type.

(3) When the primary intussusception occurs only a few centimeters from the ileocecal valve, a secondary invagination of the cecum occurs, and the roentgenographic appearance resembles that seen in ordinary ileocecal intussusception.

A. L. HART, M.D.

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Stasis of the Cecum and Ascending Colon.  
L. D. Johnson. *Jour. Kansas Med. Soc.*,  
September, 1930, XXXI, 322.

Many patients complaining of pain in the right lower quadrant submit to operation with-

out obtaining relief. Many such cases are due to obstruction or stasis in the proximal colon, usually from some congenital defect, and the cecums are occasionally found to be greatly distended at the dependent part, containing a double band. There is usually a history of prolonged low-grade pain in the right iliac fossa, extending up to the right costal margin. Reflex stomach symptoms are frequent, such as nausea, epigastric pain, acid eructations, etc. The X-ray will tell the whole story. From 6 to 10 hours after a barium meal, the opaque material will be in the cecum, where it stays for from 48 hours up to several days. One case was observed in which it remained in the cecum for 14 days. The cecum and ascending colon cannot be emptied on palpation and the area of obstruction may be visualized. In patients who have previously had appendectomies and the symptoms still remain, the X-ray examination gives the same picture.

W. W. WATKINS, M.D.

**The Clinical Diagnosis of Hypertrophic Syphilis of the Stomach.** Heinz Baumecker. *Med. Klinik*, Oct. 17, 1930, XXVI, 1557.

Syphilis of the stomach is a rare disease. It is seen in approximately only one out of ten thousand autopsies. The clinical diagnosis is very difficult. Symptoms from the stomach and a positive Wassermann reaction do not constitute enough evidence for this diagnosis. The roentgenologic findings are by no means so characteristic that one can depend on them. According to Carman and Hartwell, syphilis of the stomach should be suspected if the marked roentgenologic changes are out of proportion with a slight cachexia and anemia. Either an ulcer or a carcinoma (especially the scirrhus type) can give the same appearance as syphilis. The disappearance of clinical and roentgenologic findings after specific therapy, taken by some authors as proof, can be explained as caused by the diet régime, and self-healing of ulcers. Many cases of so-called syphilis of the stomach are not proved. The case of a thirty-two-year-old woman is described in detail. The roentgenologic diagnosis was carcinoma of the stomach. How-

ever, a laparotomy and a biopsy showed a chronic inflammatory lesion which was considered to be syphilitic.

H. W. HEFKE, M.D.

**The Reaction of the Content of the Gastro-intestinal Tract.** Frank C. Mann and Jesse L. Bollman. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1722.

The various digestive enzymes that are poured into the gastro-intestinal tract require different chemical reactions of the gastro-intestinal content for optimal activity. These reactions vary from one definitely acid for the stomach to one neutral or slightly alkaline for the remaining portion of the gastro-intestinal tract. The changes in reaction of the gastro-intestinal content, as it passes through the gastro-intestinal tract, necessitated because of the needs of the various enzymes, have formed the basis for many physiologic problems and have offered the possibility for the development of certain pathologic conditions. The actual changes in the acidity of the gastro-intestinal content and following various diets are in themselves of considerable physiologic value. The mechanism whereby the changes are graded as the content passes, for instance, from the acid secretion in the stomach to the neutral or alkaline secretion in the duodenum, also raises problems of considerable physiologic significance.

Supplementing the experimental production of peptic ulcer by Mann and Williamson, it was necessary to determine whether the theoretical considerations that made possible the development of a successful method of producing chronic peptic ulcer were correct. In order to determine this, it was necessary to observe the changes in acidity taking place in the gastro-intestinal tract, particularly at the pylorus and in the duodenum, at frequent intervals, over long periods of time, in the fasting state, and following the ingestion of various types of food. An exceedingly satisfactory method was developed, and this is described in detail. Estimation of the acidity in the fasting animal showed the gastric juices usually strongly acid, but at times almost neutral.

The content of the duodenum, jejunum, ileum, and colon is usually alkaline, with the exception that the content of the duodenum may be acid when highly acid values are found in the content of the stomach. Following a meal, the acidity of the content of the gastro-intestinal tract depends largely on the development of acid in the stomach. Short periods of high acidity of content are common in the duodenum and less common in the small intestine, the greater the distance from the pylorus. The usual reaction in the small intestine, after a meal, is close to neutral. The content of the colon is usually slightly alkaline, but may be slightly acid, especially following a meal rich in carbohydrate. Dietary measures may greatly alter the acidity of the content of the gastro-intestinal tract.

C. G. SUTHERLAND, M.D.

**The Roentgenologic Appearance of a Subphrenic Abscess on a Post-appendiceal Basis.** Oskar Meller. *Röntgenpraxis*, Dec. 1, 1930, II, 1071.

The clinical diagnosis of a subphrenic abscess is often very difficult to make. A roentgen examination may be of great value. A high diaphragm, gas under the diaphragm, and a fluid level which shifts with the position of the patient, are findings which permit a definite diagnosis. Occasionally one may demonstrate a deformity of the hepatic flexure of the colon by means of a barium enema, indicating a contact of the abscess with the wall of the colon.

H. W. HEFKE, M.D.

**Acute Intestinal Obstruction.** Irvin Abell. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1903.

A study of accumulated statistics reveals that, while acute intestinal obstruction carries an inevitable mortality, the greater portion of the mortality may justly be attributed to delay in recognition and to tardiness in the institution of appropriate surgical treatment. The underlying fact, with which all adjuvants must be correlated, is that the obstruction is mechanical and must be corrected me-

chanically. The presence of abdominal pain, vomiting, and constipation, with an absence of fever and leukocytosis, should put the burden of proof on the medical attendant to show that no obstruction exists. The flat roentgenogram, interpreted by a competent roentgenologist, in addition to the three cardinal symptoms mentioned, should permit of a working diagnosis before the accession of fever, leukocytosis, distention, and paresis indicate changes brought about by strangulation and chemical changes of the blood show profound alterations.

In the discussion of a series of papers, Case interestingly discussed the technic of the roentgenologic demonstration of acute intestinal obstruction by the flat film and the administration of a small quantity of barium in a dextrose-water mixture by mouth to visualize the small intestine.

C. G. SUTHERLAND, M.D.

**Gastric Ulcer with Gastritis in a Ten-year-old Child.** Franz Herz. *Röntgenpraxis*, Dec. 1, 1930, II, 1077.

Gastric ulcers in children are rare. Such a case in a ten-year-old child is described, with special reference to the roentgenologic findings. A crater could be demonstrated at the lesser curvature, close to the cardia.

H. W. HEFKE, M.D.

**The Diagnosis of Gastric Lesions by Intra-gastric Photography: Preliminary Report.** Reuben Finkelstein. *Ann. Int. Med.*, January, 1931, IV, 804.

While lesions along the curvatures are readily diagnosed by the X-ray examination, lesions of the walls are more difficult, or impossible, of diagnosis.

The development of intra-gastric photography makes possible an accurate diagnosis of lesions which would otherwise be difficult of diagnosis.

The gastro-photor consists of a semiflexible tube carrying at its distal end a double camera, an upper and a lower, between which is a small electric bulb so constructed that when activated by a transformer it yields a bluish-

white light of 12,000 candle power for 1/120 of a second, and is then destroyed. The transformer takes its energy direct from the house-lighting current.

Each camera contains four small films regularly disposed in a circle, and by means of two pinpoint holes, upper and lower, a stereoscopic picture is taken by each film of a 90-degree arc of the circumference; thus at each exposure eight double stereoscopic views are taken. Films are marked so that one can tell what part of the circumference of the stomach is shown on the film. A full description of the technic employed is given. The author arrives at the following conclusions: "Like all other means of diagnosis it is not infallible, and will not replace the X-ray or clinical evidence of gastric disease. There are, however, a large number of cases in which the diagnosis cannot be made and only a gastro-photor picture will reveal the lesion."

C. H. DEWITT, M.D.

**A Contribution to the Diagnosis of an Obstruction in the Upper Small Intestines.** C. Wittkowsky and Metzger. *Röntgenpraxis*, Nov. 15, 1930, II, 1042.

A case of an adenocarcinoma of the jejunum is reported on account of the rare occurrence of such tumors. The roentgenologic examination showed a definite but incomplete obstruction and dilatation of the upper jejunum. Operation and autopsy confirmed the diagnosis.

H. W. HEFKE, M.D.

**Acute Intestinal Obstruction.** Frank Smithies. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1899.

When acute intestinal obstructions are suspected, roentgen studies are to be condemned if they include the employment of barium mixtures. Four patients of the author's series had X-ray progress meals administered after there had accumulated sufficient proof, clinically, that an acute abdominal lesion existed. In all instances, the stimulus of the opaque meal, combined with the weight of the digestively inert barium, resulted in the acute intestinal obstruction being converted into acute

intestinal perforation. Only one patient recovered. At times, certain valuable information may be secured by the roentgen study of gas-filled loops of bowel. In the films it may be possible to demonstrate approximately where the obstruction lies; at least, one may state, with fair accuracy, that the obstruction is in the small and not in the large bowel. There are instances in which sufficiently sharp gas shadows will enable a definite diagnosis of jejunal, in contra-distinction to an ileac, obstruction.

If roentgenographic studies can be made without loss of time and undue moving about of the patient, they should form a part of every routine examination. Not only may these "scout films" give information that is valuable diagnostically, but a study of the gas shadows may prove of great help in aiding the surgeon to better plan his operative procedure. When perforation of the bowel has already taken place, and when the patient had previously been taking medicine, such as bismuth, the shadow cast by the escaped opaque substance may indicate where the perforation is. In such circumstances, films serve as a caution against immediate operation. Proof of free-lying bismuth shown roentgenologically, suggests a waiting policy that may save the patient's life.

C. G. SUTHERLAND, M.D.

**The Incidence of Hemorrhage in Perforated Gastric and Duodenal Ulcers.** Moses Behrend. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1889.

Ulcers of the stomach and duodenum manifest themselves in various ways. They are selective in their location, time of perforation, and incidence of hemorrhage. "Perforated ulcers rarely bleed and bleeding ulcers rarely perforate." The varying degrees of morbidity caused by ulcers depend, to a large degree, on their location. The author's research findings coincided with those of Einhorn, namely: "The arteries in the submucosa in the pyloric region of the lower lesser curvature of the stomach are practically terminal vessels and are relatively sparsely distributed, giving a limited blood supply to this area. They are

tortuous, anastomose infrequently, and are subject to powerful and repeated forcible contractions by numerous interlacing, intrinsic, and frequently contracting muscle bundles. These constrictions tend to interfere with the circulation and, moreover, the terminal vessels are subject to the same tendency to circulatory interference by reason of easy blocking, as are the terminal vessels in the brain, or kidney, and are especially liable to harbor the foci of anemia."

Ulcers that give rise to hemorrhage are more apt to occur in the pliable elastic tissue of the stomach than in the dense area around the pylorus. No definite place can be assigned to this type of ulcer. There is some difference of opinion whether surgeons should or should not operate. In the author's opinion, it is an error of judgment to defer operation in hope the ulcer may not bleed again. Perforated ulcers occur more frequently than bleeding ulcers. The bleeding ulcer is usually an acute condition, hence the area affected is much smaller in extent. It is interesting to note the gross pathologic differences *in vivo* between the chronic ulcer, the perforating ulcer, and the bleeding ulcer.

C. G. SUTHERLAND, M.D.

**Sigmoidoscopy versus X-rays in the Diagnosis of Terminal Bowel Disease.** Frank C. Yeomans. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1907.

Refinements in the technic of roentgenology and improvements in proctoscopes have made these two agents prime factors in the diagnosis of gastro-intestinal diseases. Each method has its indications, advantages, and limitations, and frequently the two are materially helpful in arriving at a correct diagnosis. In the relatively fixed rectum and distal sigmoid colon, which are situated largely within the bony pelvic girdle, the X-rays are of comparatively limited value. Prominent defects are: (a) an important lesion may be missed entirely; (b) although the site and apparent extent of a lesion are discovered, especially if it is of a stenosing character, its nature is frequently not disclosed; (c) in many cases, interpretation of the image is so uncertain as to cast grave doubts on the diagnosis. For

example, amebic colitis in its early stages or before secondary infection of the ulcers has occurred, may present the same symptoms and roentgenologic appearance as ulcerative colitis, but viewed through the proctoscope, the early lesions are characteristic and pathognomonic. In examination of the terminal bowel the usual order of procedure should be reversed, sigmoidoscopy being first in order. Endoscopy usually establishes the diagnosis of lesions in the rectum and the pelvic colon. Negative endoscopic observations are valuable data for the roentgenologist. The X-ray comprises the best available agent for determining the extent of involvement in ulcerative colitis, and in detecting tuberculosis of the cecum; it is our chief reliance in demonstrating diverticulosis of the colon, and especially diverticulitis of the sigmoid, and, rarely, it may discover a double primary carcinoma in different colonic segments.

C. G. SUTHERLAND, M.D.

**A Contribution to the Roentgenologic Diagnosis of Ulcerative Colitis.** Hans J. Teschendorf. *Röntgenpraxis*, Dec. 1, 1930, II, 1087.

The roentgen examination of the colon by means of a barium enema is of great clinical significance in the diagnosis of ulcerative colitis. The results are better when the films are taken after the patient has expelled the enema, as the "relief" of the mucous membrane is more clearly demonstrated. The method of A. W. Fischer (combination of barium enema and air inflation) gives plastic pictures, but does not show the mucous membrane.

H. W. HEFKE, M.D.

**Diet in Chronic Gastric Ulcer.** Editorial. *Jour. Am. Med. Assn.*, Dec. 13, 1930, XCV, 1838.

In the words of the editorial writer: "The successful treatment and healing of gastric ulcers involves many factors of uncertainty, reflected in the multiplicity of suggestions from therapeutists. For example, a recent writer asserts that the establishment of proper habits of eating, the avoidance of notoriously

irritating articles of food which offend the gastric organ because of chemical, mechanical, or thermal insults, the minimization of worry, strain, and hurry—at least at meal times—the removal of infection from teeth, tonsils, and accessory sinuses, the prevention of chronic constipation by regulation of diet and exercise, and the surgical removal of disease elsewhere in the abdomen, are measures that tend to lower the incidence of ulcer. He adds that these are essential features in the treatment of ulcer whether or not surgery is employed. . . . Experimentation is singularly difficult in human cases; hence it is proving to be of great advantage that characteristic gastric ulcer can be developed with considerable success in experimental animals. In the latter it has been observed that relative hyperacidity and hypernormal secretion, such as are associated with partial pyloric stenosis, are not necessarily such important factors in the delay of healing as was formerly assumed."

He continues: "Mechanical factors, however, can delay the healing of an acute lesion of the gastric mucosa, and acids make the ulcer more irritable or susceptible to bleeding. Fauley and Ivy have further pointed out that coarse particles of food remain in the stomach longer than fine particles, which obviously results in more prolonged motor activity of the stomach and increases the trauma to an acute lesion of the mucosa. This would be pronounced in a patient with pylorospasm. In studies at the Northwestern University Medical School, Chicago, they have demonstrated that certain types of acute experimental lesions of the gastric mucosa are definitely harmed by a "rough" diet. For instance, a simple ulcer of the rabbit's stomach, produced by excision, heals within thirty days, irrespective of the consistency of the diet. A similar ulcer, but with a silk suture in its base, will heal if the rabbit is fed a soft diet, but will tend to become chronic if the rabbit is fed a "rough" diet. Therefore, Fauley and Ivy conclude that in chronic ulcer in man a soft diet would facilitate the healing of an ulcer, which confirms clinical experience and supports the use of a diet of the character of that employed in the generally accepted therapeutic procedures for gastric ulcer."

C. G. SUTHERLAND, M.D.

A Contribution to the Roentgenologic Diagnosis of Chronic Obstruction of the Small Intestines. G. Lemmel. Röntgenpraxis, Nov. 15, 1930, II, 1034.

The roentgenologic study of pathologic lesions of the small intestines has not been developed as much as in the case of the stomach, duodenum, and colon. It is necessary to examine the small intestines frequently after a barium meal, over twenty-four hours or more. A definite localization of the obstruction and its nature may thus be reached in a large percentage of the cases. The horizontal fluid level, with gaseous distention of the small intestines, fixation of some loops, and distention with barium, are all only indirect symptoms. The demonstration of the obstruction itself gives a much better chance for a precise diagnosis.

H. W. HEFKE, M.D.

Roentgen Diagnosis of Ascariasis. Vincent W. Archer and Charles H. Peterson. Jour. Am. Med. Assn., Dec. 13, 1930, XCV, 1819.

In September, 1929, during a routine roentgen gastro-intestinal examination of a child, certain signs were correctly diagnosed as being caused by *Ascaris* in the intestinal tract. No reference was found in the English literature, so experimental work was started on a group of children infected with *Ascaris*. A subsequent search of the foreign literature revealed several references. The ova from polluted soil are ingested and hatch in the small intestine. The larvæ migrate through the intestinal walls, enter the circulatory system, and are carried to the capillaries of the lungs. Here they develop in the air sacs, give rise to pulmonary changes, pass up the bronchial tree, and are swallowed. After liberation from the lung, about six weeks is required for maturity. A constant supply of fresh larvæ is being supplied by the lungs, even after an anthelmintic has cleared the intestinal tract of parasites.

A series of 60 patients, with stools positive for *Ascaris* ova, were studied roentgenologically. Of 57 children, 54 showed the very definite, typical roentgen appearance to be



described. Only one of the adults showed this. Films are made at one, two, and four hours. At first there are cylindrical filling defects, especially in the jejunum, from 5 to 8 mm. in diameter, and from 15 to 20 cm. in length. Later films show string-like shadows in the central portion of the filling defect. These are interpreted as the barium-filled enteric canal of the parasite. An interesting incidental observation has been that the parasites will not ingest the barium if the patient has eaten prior to drinking the contrast meal, and consequently the enteric canals will not be outlined. Roentgen evidence is occasionally definite in the absence of ova in the stool.

C. G. SUTHERLAND, M.D.

**The Origin of Polypi of the Large Bowel, with Especial Reference to Adenoma: Preliminary Report.** W. A. Fansler. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1969.

Polypi may occur in almost any portion of the intestinal tract, but approximately 75 per cent occur in the large bowel. Broadly speaking, any pedunculated tumor extending into the lumen of the bowel may be termed a polypus. Of the most unusual types may be mentioned fibromas, lipomas, and myxomas arising from the areolar tissue of the bowel wall; myomas, arising from the muscular coats, and hemangiomas, arising from the blood vessels. Post-sacral dermoid cysts and meningocele may arise outside the bowel and protrude into the lumen of the intestine in a polypoid fashion. Occasionally there is a polypoid growth due to parasites. A second group has to deal with the epithelium of the large bowel. A type is seen in cases of ulceration of the large bowel due to ulcerative colitis, amebic dysentery, syphilis, tuberculosis, and other inflammatory conditions. These are in no sense true tumors, as there is no growth of epithelial tissue.

A second type is the adenoma or adenomatous polyp. These tumors are true adenomas, whose epithelial structure is derived from the cells of the intestinal mucosa. They protrude into the bowel lumen and eventually become polypoid through the traction of their own weight, the pulling of

the fecal current, and the peristaltic action of the bowel itself. The adolescent (congenital disseminated) type is seen in the first two decades of life. Children usually have a single adenomatous polyp. The author has never seen a case in which the bowel was studied with numerous adenomatous polypi in a patient under 18 years of age. As a rule, single adenomas occur in the earlier years of life and multiple adenomas in the later years. It is fairly obvious that some tendency of an individual to form adenomas does exist. In some cases, a definite family tendency can be shown. Adenomas are frequently found in chronically inflamed areas, or the primary change may occur in the epithelial cells and the inflammatory change may be secondary. The fact that the mucosa adjoining the adenoma is frequently normal would point to this. The author believes that the tumor begins as an enlargement of a small submucous nodule of lymphoid tissue and the epithelium over it is normal. While the exciting cause or causes of the formation of adenomatous polypi of the large bowel are not definitely known, he is convinced that the earliest demonstrable pathologic change is not found in the areas of the mucosa lining the bowel, but as a nodule of lymphoid cells in the submucosal tissue.

CHARLES G. SUTHERLAND, M.D.

### GASTRO-INTESTINAL TRACT (THERAPY)

**Visceroptosis: Its Clinical Significance and Treatment.** Edward L. Bortz. *Am. Jour. Med. Sci.*, July, 1930, CLXXX, 59.

In 1885, Franz Glénard first described the condition now known as visceroptosis. Since that time numerous articles have appeared in the literature, emphasizing the importance and various phases of this condition.

The author has analyzed 100 cases, according to age, incidence, sex, chief complaints, physical findings, previous operations, organs involved, accompanying lesions of the pelvis, additional diagnoses, important factors in the production of visceroptosis, probable important factors in the production of symptoms, re-

sults of treatment, and complicating factors in unimproved cases. He has also analyzed the opinions of twenty leading radiologists in four different countries.

He arrives at the following conclusions:

(1) Visceroptosis is a condition of downward displacement of the abdominal viscera that may exist in individuals who appear to be in perfect health.

(2) The condition may be primary, that is, hereditary, or it may be acquired following somatic devastation from overwork, repeated pregnancies, prolonged disease, etc.

(3) In a series of 100 cases studied in the Lankenau Hospital Medical Clinic the chief symptoms have been analyzed here. They usually pointed to the gastro-intestinal tract.

(4) Satisfactory therapeutic measures depend upon a consideration of the cause of the symptoms.

(5) In the Lankenau Clinic a definite daily program is planned for each patient including proper diet, elimination, rest, massage, and, when indicated, mild sedatives. All foci of infection are eradicated and, in selected cases, a Page abdominal support is applied. In a small percentage of cases requiring surgical intervention the fundamental *rationale* of the treatment should not be neglected.

ROE J. MAIER, M.D.

**Subtotal Gastrectomy for Duodenal Ulcer: Ten Years' Experience and Clinical End-results.** Alfred A. Strauss, Leon Bloch, J. C. Friedman, Jacob Meyer, and Morris L. Parker. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1883.

This study is based on the results of 221 subtotal gastrectomies for duodenal ulcer. It represents the combined opinions of a stomach-study group, composed of surgeons, internists, roentgenologists, pathologists, research fellows, and a member of the social service department. The latter member studied the economic conditions of peptic ulcer patients before and after medical treatment, as well as before and after operation. All chronic gastric ulcers should be treated surgically because of the difficulty of deciding whether or not a gastric lesion is an ulcer or beginning carci-

noma, and of the possibility of fatal, or near fatal, hemorrhage. Every duodenal ulcer should have the benefit of at least one thorough medical treatment, irrespective of the patient's economic condition. In cases in which the ulcer is not bleeding or perforating, the patients are usually relieved of their symptoms after two weeks' rest in bed and the usually accepted routine medical management. If the roentgen examination shows a clover-leaf deformity of the duodenum, little can be expected from medical treatment. The majority of these are due to an ulcer on the posterior duodenal wall, perforating into and adherent to the pancreas. Experience has shown that these ulcers do not heal, as the patients suffer not only from the ulcer but from mechanical difficulties. Pathologically, in addition to the duodenal ulcer, there is often associated a cholecystitis and pancreatitis, aside from gallstones.

The authors have formulated two basic laws for the successful surgical treatment of ulcers: (1) That the pathologic tissue should be removed, including the first portion of the duodenum and the lower half of the stomach; (2) that the stomach must have a rapid, or quicker than usual, emptying time. Subtotal gastrectomy, in their opinion, is the only operation which fulfills these laws. The mortality in their series of surgical cases was 5.4 per cent. The clinical end-results showed 95 per cent symptom-free on no particular diet or medication, and the gain in weight has been from 15 to 50 pounds.

CHARLES G. SUTHERLAND, M.D.

**The Results of Medical Treatment of Peptic Ulcer.** Ralph C. Brown. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1144.

The forms of treatment, in general, used prior to 1915 were chiefly based on bland foods, rest in bed, hot fomentations, and minimal doses of alkalis. Sippy recognized the important influence of the digestive action of gastric juice on the unprotected raw surface of a gastric or duodenal ulcer. He advanced the theory that healing of peptic ulcer could best be achieved by elimination of the chemical digestive action. He suggested neutrali-

zation of free hydrochloric acid in the gastric content from breakfast until bedtime, with special emphasis on the control of any existing hypersecretion during the night hours. The application of this theory resulted in the hourly-feeding schedule and the intensive use of alkalis of various types.

Two facts have emerged from continuous clinical experience with ulcer-bearing individuals. First, that by far the greater proportion of gastric and duodenal ulcers can be healed by proper medical measures. Second, that these lesions tend to recur, either at the original site or in a different area of the stomach or duodenum. A survey has been made of all cases treated by Sippy and the author over a period of fifteen years. Questionnaires were sent to 1,900, and the replies made possi-

ble a study of 1,224 cases. The clinical data are reviewed; the roentgen data were available in only 1,036 cases. Duodenal ulcer was diagnosed in 923 cases, gastric in 77, and duodenal and gastric in 12. Of the 1,130 cases treated medically, 49.5 per cent were reported cured; 16.7 per cent satisfactorily improved, and 10 per cent moderately improved. In 20 per cent medical measures failed. Approximately 20 per cent of the patients with gastric and duodenal ulcers now being admitted to hospitals require surgical care. Because of the lack of basic knowledge regarding the etiology of ulcer, the inability of physicians to insure an ulcer-bearing individual against recurrence constitutes the most serious problem to be faced.

C. G. SUTHERLAND, M.D.

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For a long time Keleket engineers have been experimenting with valve tube type of rectification. Various models of equipment were built and tested; however, none was placed on the market, due to the fact that the designs were more or less conventional and, for that reason, had the limitations of valve tube rectified apparatus as it was then known. Until such time as definite improvements could be presented over existing designs and until the fallacies were corrected or eliminated, the Kelley-Koett Company recommended Mechanically Rectified Apparatus to its customers.

The difficulties present with conventional designs were—firstly, the inability of the operator to calibrate his equipment with a sphere or spark gap after installation; secondly, there was no method of automatically controlling the filament temperature of the valve tubes used for rectification; and thirdly, the current output of such apparatus was about half that permissible with Mechanically Rectified Equipment.

It is well to be able to measure the voltage output of an X-ray machine in order that the operator may know the exact maximum voltage stress placed across an X-ray tube.

Automatic control of the filament temperature of rectifying tubes is essential because the lack of this feature may cause the shortening of the valve tube life.

The basic design of a valve tube is similar to that of an X-ray tube—that is, it has a heated filament providing a source of electronic emission and a target or anode, on which this electronic emission is focused. A valve tube differs from an X-ray tube in that the filament is much larger, thereby providing an abundant source of electronic emission, and the resistance of the tube becomes negligible to passage of current in the proper direction.

A valve tube which does not have the filament heated to a certain necessary degree of temperature will take on the characteristics of an X-ray tube. This is evident—firstly, by an increased voltage drop across the tube and less voltage output to the X-ray tube; secondly, by the heating of the target of the valve tube caused by the high speed bombardment of the target by the electronic stream; and thirdly, the tube becomes excessively hot and no longer rectifies but passes alternating current which will immediately cause destruction of the adjacent valve tube in the rectifying circuit, likewise possible destruction of the X-ray tube.

In an attempt to compensate for the foregoing valve tube limitations, conventional equipment was designed with a variable voltage regulator to control the heat of the filaments in the valve tubes. This control was necessary because, should the apparatus be operated at a high current, the accompanying voltage drop of the line would drop the heat of the filaments in the valve tubes, thereby causing tube injury. To correct this, the heat of the filaments of the tubes was increased beyond normal so that when a drop in voltage came there would be sufficient heat for the proper operation of the valve tubes. The falseness of this procedure is evident, due to the fact that the filaments were subject to superheating, causing short life. Also, the human element materially entered into the operation of the equipment, permitting apparatus injury due to faulty operation. The operator was usually instructed to set the regulator at definite points per technique used. At 5 Milliampers the heat of the filaments was low, and at high currents excessively high.

The variable voltage control arrangement for the filaments of valve tubes is not in keeping with the specifications governing most efficient valve tube operation. Practically all valve tube manufacturers, domestic and foreign, recommend a definite setting of filament current which permits an abundance of free electrons in the tube, thereby lowering

the tube resistance and permitting efficient rectification with little voltage drop in the rectifying tube, a lack of heat on the target and, furthermore, a higher permissible current operation. It is only with 1000 Milliampere Valve Tubes that the manufacturer recommends a higher filament heat than normal for high current operation and it is preferable to make this change with a positive throw-over switch to give the exact rating automatically as recommended by the valve tube manufacturers.

With the foregoing in mind, the Kelley-Koett Mfg. Company has adapted the voltage stabilizer to the rectifying circuit of valve tube apparatus. With this arrangement, the valve tubes are operated at the correct filament heat regardless of line voltage fluctuation or line drop when heavy currents are used. The maintained temperature of the filaments permits the valve tubes to operate at the point of greatest efficiency and least resistance.

A Power Stabilizer is connected in the filament circuit of the valve tubes, maintaining all filaments at a definite operating temperature of the exact specifications of the valve tube manufacturer. This constant temperature is maintained regardless of a 50% plus or minus voltage variation caused by any reason whatsoever.

The stabilized control of the valve tube filaments makes permissible the use of much higher current techniques with Keleket equipment than are available on conventional types. Furthermore, it is recommended that either sphere gap or spark gap be used for direct voltage calibration of the equipment as the short circuit load caused by sphere gap calibration will have no effect on the valve tube life or operating characteristics of the equipment.

The Stabilizing Unit functions so perfectly that it is actually possible to directly short-circuit the high tension rectified current, placing the full output capacity of the transformer directly across the rectifying tubes and depressing the exposure switch time and time again with no effect on the tubes. The Stabilizing Unit maintains the filament current constant under this extremely heavy short-circuit load operation and the adjustable circuit breaker opens the transformer line before any injury is done to the low tension circuit carrying parts.

From the foregoing, it can be readily appreciated that Valve Tube Rectified Apparatus presented by Keleket not only has all the advantages previously suggested with tube rectification, but none of the disadvantages presented by conventional types of equipment. In other words, it is a consummation of all the advantages of valve tube and mechanically rectified equipment with none of the disadvantages of either.

The Kelley-Koett Mfg. Company, after due experimentation and deliberation, has placed on the market models of valve tube rectified equipment which are competitively non-comparable. With particular reference to the Radiographic Unit, the Kelley-Koett Company does not make any claims of increased radiographic speed or increased contrast in negatives. Radiographic speed is primarily governed by high power factor transformer design rather than by rectification. The greater efficiency in the deep therapy equipment results from the use of high capacity condensers which act as storage units for the current, receiving impulsing direct current and delivering relatively uniform current to the X-ray tube.

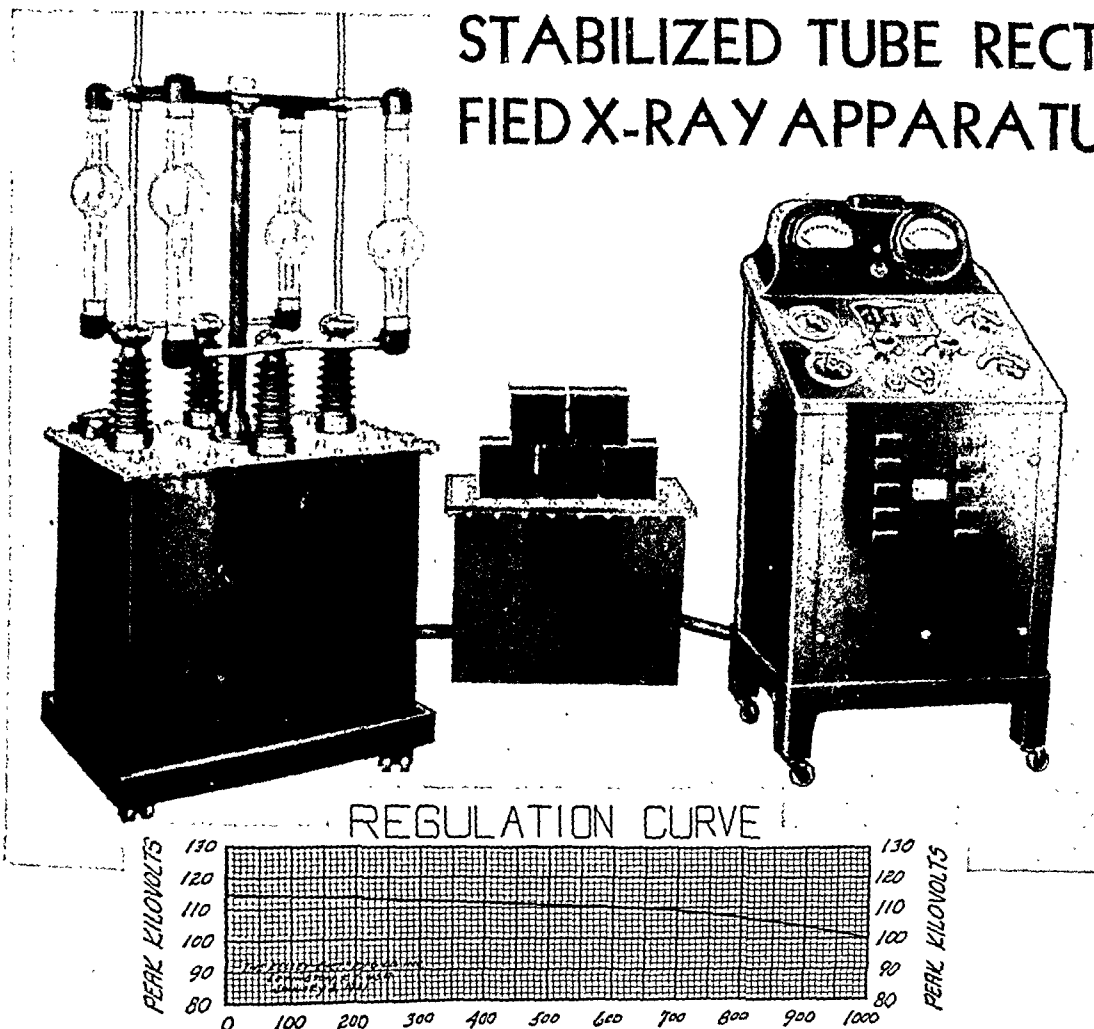
With the announcement of valve tube rectified equipment, the Kelley-Koett Company is presenting to the medical profession apparatus, the designs of which are a result of a long period of experimentation. Keleket does not pattern after the conventional—it presents new standards for comparison!

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## Third International Congress of Radiology

*Paris, July 26 to 31, 1931*

### Brief Preliminary Sketch of Official Pre-Convention Tour

LEAVE NEW YORK JULY 6TH, 10 P. M., STEAMER FRANCE, first class, arrive Havre July 14. Belgium, Holland, Hamburg, Berlin, Prague, Vienna, Switzerland, Genoa, Monaco, Marseilles, arriving Paris July 26, A. M. Paris in convention to July 31st.

Post convention tour to British Isles or Russia optional (details on request). Societies tour officially ends when convention ends, but every one furnished with ticket back to United States good on any French Line cabin steamer. No attempt is made here to give list of things we do in the above cities and countries except to say we cover everything of interest in the best manner. The ladies will be entertained while the doctors are at clinics.

**THE PRICE INCLUDES** one night at Hotel New Yorker or Hotel Lincoln (no meals) night before sailing, in New York City. Baggage insurance \$300 per person, covering loss, damage, pilferage, etc. Accident insurance \$10,000. (Common carrier.)

Eastbound: Steamer France, first class minimum (elaborate rooms proportionately more at tariff rates). Westbound: Any French Line cabin ship. All Government taxes. Visas (but not passports).

Rooms at hotels and all meals (except dinners in Paris during convention). All admission to places visited. All handling of baggage. All taxis. One all night party Paris, to Folies Bergere, La Boheme, Le Perroquet, Zelli's, La Tour D'Argent, etc.. On this party champagne is included (any quantity).

You have nothing whatever to do after you leave the hotel in New York except to go in one of our taxis to the ship. We perform complete courier service. Stops are one and two days, although account of Clinics more interesting in certain cities (for instance, Vienna or Berne) an additional day might be spent. Travel is by ocean liner, train, Rhine river steamer, taxi, DeLuxe autos and in one or two instances short trips are made by motor coach. Special trains if convention is complete 200 persons. All general tipping.

**NOTE:** The Doctors are leaving as an official party on the France, July 6th, taking the Continental tour and Clinics before the Paris convention because Clinic work is much more interesting in July than August (August being a standard vacation month for Physicians in Europe).

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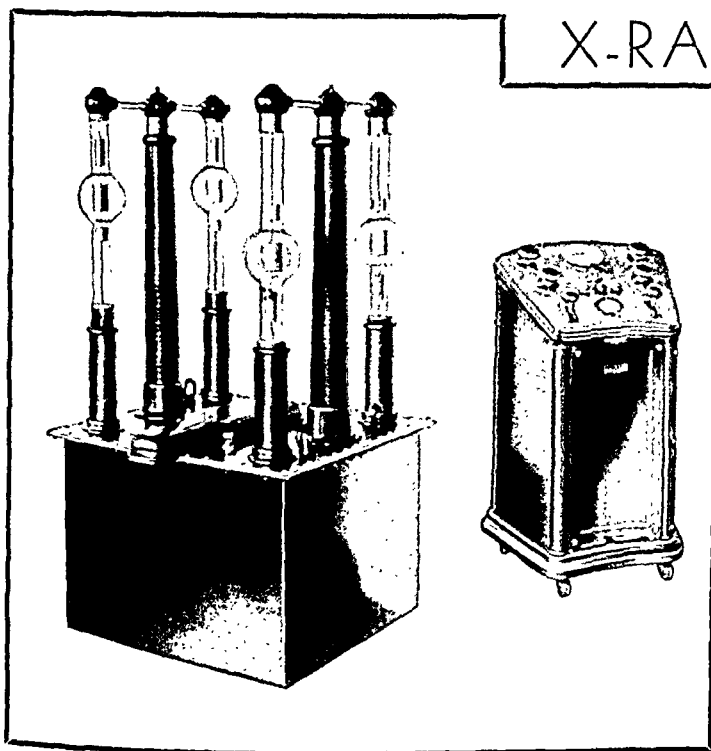
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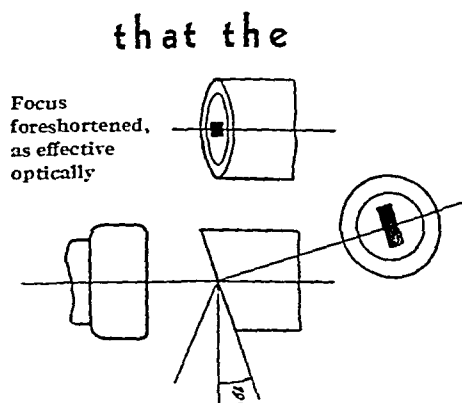
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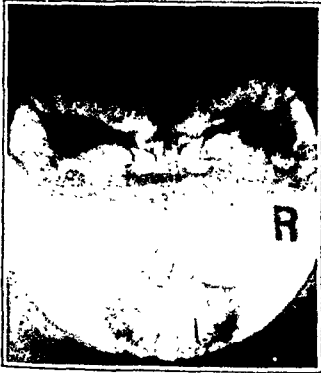
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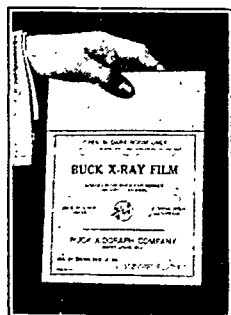
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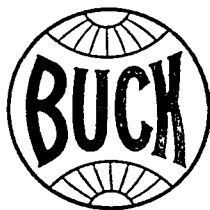
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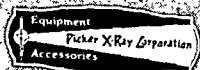
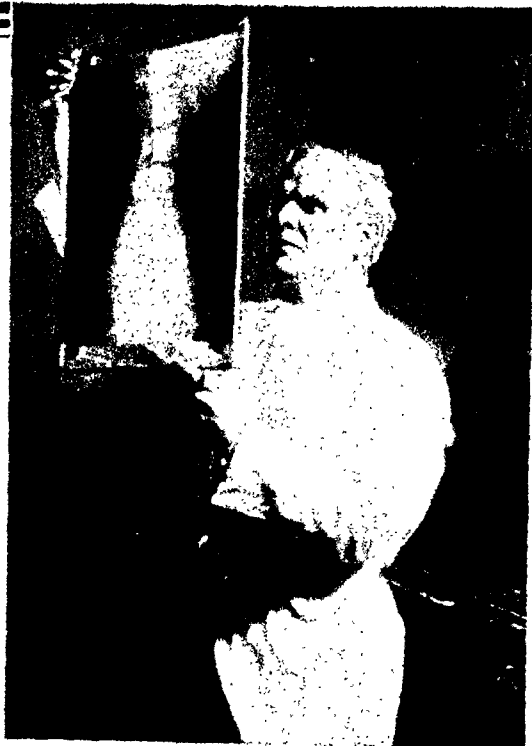
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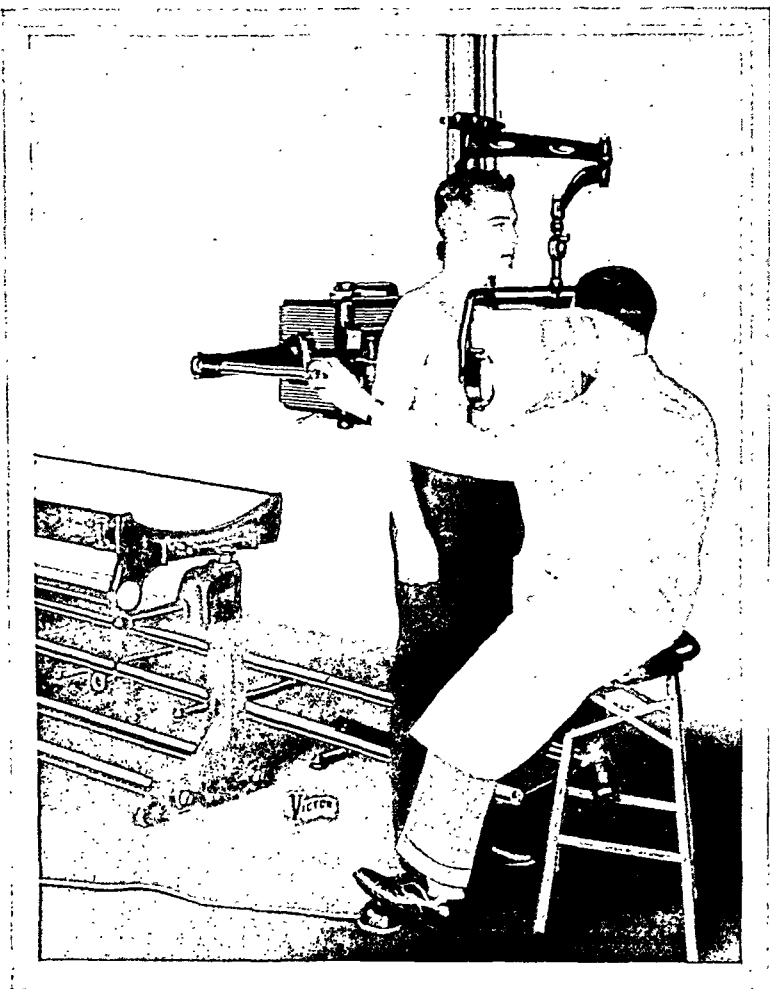
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## PALLIATIVE RADIOTHERAPY OF MALIGNANT GROWTHS<sup>1</sup>

By FRANCIS CARTER WOOD, M.D., NEW YORK CITY

THE last few years have witnessed a remarkable change in attitude toward the problem of cancer therapy. The statistical study of the disease, with more careful death records and more autopsies, has shown that there has been in most countries like our own with defective death certificates, a large amount of unrecognized cancer. The statisticians feel that with the discovery of all this material, the cancer death rate will rise to something like 125 per 100,000, instead of the 95 per 100,000 which is now the official figure for the cancer rate in the United States. The propaganda of the American Society for the Control of Cancer has led to a demand from the public for more efficient therapy than the medical profession has been prepared to give, while studies of the records of hospitals have shown the relative inefficiency of cancer treatment when all types are included, only some 20 per cent of patients admitted to the hospitals being operable. Then the utterly unsupported claims for cures which followed the development shortly after the War of high voltage X-ray apparatus caused the surgeons to study their own material with much more care, the results being a sudden sobering of the operative claims when cases were followed for periods of five years and more. Time has shown that neither the exaggerated statements of the

earlier roentgenologists were true, nor could the surgical statistics of twenty years ago be regarded as in any way representing the real results when patients were properly followed. What has arisen from the situation is, of course, the fact that surgery is still effective in certain groups of tumors and also that carcinoma of the cervix, especially the borderline groups, can be better treated by radiation than by surgery. The sobering attitude of all these facts is reflected in the changed attitude of the whole profession toward the actual cure of cancer, and the word "arrest" is now being used by those who try to make their language fit the facts. In some ways the surgical pessimism has gone a little too far, for a study of the material has revealed the disheartening fact that a patient cured of one tumor is perfectly capable of developing another one later,—a matter which should have been expected from the multiple occurrence of tumors in the same individual. In fact, recent studies have shown that this multiple occurrence is just what would be expected statistically from the frequency of cancer in the general population, that is, a certain number of patients might well develop two tumors, either simultaneously or within a short time of each other. It is, therefore, nothing astonishing that a woman cured of a carcinoma of the cervix may a few years later develop a carcinoma of the breast. Fortunately these double carcinomas are relatively rare.

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

In the past, both surgeon and radiologist confined their attention to what they called "cures." The surgeon in such statements was on much sounder ground, for in a certain proportion of accessible malignancies he really did produce a cure. In my own records, and those of many other institutions, there are, for example, many cases of carcinoma of the breast which can be considered as cured in the true sense of the word, that is, they have gone eight to ten years without any evidence of return. True, recurrences have been seen after fifteen years or more in the regional nodes, lungs, or bones, but again, these are very infrequent. Only in carcinoma of the cervix and the skin are there any such long-time records of real cures from radiation. But if only 20 per cent of the hospital material is operable, what shall be done with the remaining 80 per cent? Many of these are entirely beyond any therapy. The results of radiation treatment of carcinoma of the lung, of the stomach, of the liver, pancreas, kidneys, prostate, and esophagus have in general been an utter failure when regarded from the point of view of permanent results, and in most of these sites—even from the palliative aspect, with but rare exceptions—nothing has been obtained. The operative achievements on carcinoma of the stomach, even in those cases which were considered operable, have been small. Carcinoma of the rectum has been somewhat more favorable in its surgical aspect because of the possibility of removing the gut completely and also because of the rather low grade malignancy from the surgical point of view of many of the neoplasms which attack this viscus. The same is true of certain other localities, when the patients come in the early stages for treatment. On the other hand, radiologically the rectum and sigmoid have been two of the least satisfactory, for the slow-growing mucus-forming tumors of this region, which are the most common type and metastasize late, and are therefore favorable to surgery,

have been so resistant to radiation that little palliation has been obtained.

Thus successful radiation implies an additional requirement not implicit for the surgical cure of a growth, that the neoplasm is radiosensitive. In some instances this is closely correlated with microscopic morphology, but one often meets with exceptions.

In the attempt to achieve the impossible by both surgery and radiation, extensive operative procedures, with a high resulting mortality, have been tried, but are now being abandoned. In the past, excessive radiation dosage, with serious damage to the patient's general health, has not been infrequent. But gradually the attempt to cure the incurable has been abandoned by both parties and a saner view prevails.

The destructive dose for tumors varies in man between 700 r-units and 7,000 r-units or more. The average is probably close to that of the transplanted animal tumors, which requires between 2,500 and 3,500 r-units for a complete destruction of all the cells. It is evident that human tumors of the higher degrees of radioresistance must be treated not only with external radiation through the skin, but an additional dose must be added by interstitial radiation with filtered radium, either element or emanation. Here the accessibility of the tumor to be treated plays as important a part as it does in surgical operability. Just as at least 80 per cent of those who apply for treatment for malignant tumors are already in an inoperable stage, so at least the same proportion are not in a condition suitable for the application of radiation for a cure.

If the patient is inoperable from the point of view of cure, and nothing can be promised from the radiation side, what may be done to prolong life within the limits of comfort or of ability to work? That is the point concerning which I wish to speak. Frankly confessing our inability to cure a certain group of tumors by any method, how far can we go with surgery, with radiation,

or with the combination of the two to prolong life in comfort? To be effective, such surgery must not be dangerous to the life of the patient, and the radiation must not be so heavy as to render the patients so miserable that they cannot go about their daily duties for a time. It is difficult to evaluate the results in statistical terms, for there is as yet but little accurate information on the length of life of the untreated patients, and nowadays there are relatively few patients who are never treated in some fashion. I have elsewhere made an appeal for the compulsory notification of all cases of cancer as soon as diagnosed, with the hope that the material so obtained might be used to give us further information on this important point, for it is easily seen that the mere collection of a series of patients with carcinoma of the rectum, for example, adding up the years and months that they survive, and dividing by the total, gives us no practical information. Unless it is possible to add to the crude survival periods some information concerning the histological types of tumor, their sites and distribution, the figures will be of but little value. Thus I have seen a patient with carcinoma of the rectum live seven years with a simple colostomy, but how many tables exist of a large series of patients treated with simple colostomy, with the microscopic examination of the tumor to correlate, if possible, the length of life with the histology? Until this is done we have no firm basis for assuming that radiation or surgery really does prolong life. All we can do is to study the individual and judge from his clinical course whether or not our therapeutic measures have been useful. And it must be frankly confessed that in not a small number of instances our best therapy fails to check the course of the disease, and the only thing which we can claim is that the patient's mental condition has been improved.

Take, for instance, the advanced, ulcerated carcinoma of the breast. What is the right thing to do for these unfortunate pa-

tients? Surgery offers no cure; neither does radiation. The nodes and thoracic wall are involved; mediastinal and bone invasion is probable. Nevertheless, in my own experience I have felt that the removal of the breast and as much skin as is possible without recourse to grafting, leaving the nodes in the axillary and supraclavicular regions undisturbed, does help these patients. With our present operative technic the mortality is extremely low. The anesthesia is not dangerous; the operation can be done in a relatively short time, and the patient can leave the hospital in ten days or two weeks. The mental horror which accompanies these huge ulcerating masses is relieved. The patient no longer is an offense from the odor which follows the invasion of putrefactive organisms into the necrotic material. Dressings are no longer needed, and the patient is relieved of that expense. As soon as the wound is healed post-operative radiation with moderate voltages should be given over the nodes of the neck, the axilla, and the entire skin surface in which invasion may be expected. If the patient begins to cough, high voltage doses should be directed to the mediastinum. X-ray films will often reveal nodules in the chest to which attention can be directly paid during the course of the radiation. The cough, of course, is due to the pressure on the bronchi and trachea, with consequent narrowing of the lumen, retention of secretion, or irritation from invasion of the bronchial wall. Many of these patients can have their cough relieved for considerable periods. The accumulation of pleural exudate also is checked. If the bones are involved, they can be radiated, with the relief of pain. In most patients of this type no local skin recurrence will follow if sufficient radiation is given. This means treating these persons every week or two for some time over the suspected areas. In my own material a number of these patients have been able to go back to work and be fairly comfortable for varying periods of from six

months to four years. If the tumor metastasizes in the bone it usually does not seem to involve the lung, and the reverse is true. The bone cases are the most suitable for the prolongation of life. They can be rendered

dence is pretty clear that she had early bone involvement, because she noticed a pain in the right femur January 7, 1925, and X-ray films (Fig. 1) taken at that time showed extensive metastases into the right femur and



Fig. 1. Lesion found March 17, 1925, showing extensive erosion of the pelvic bones.

very comfortable by moderate radiation, whereas the lung cases as a rule go rapidly, but if sufficient radiation is given, the cough can be kept down, as has already been said, and when the fatal termination comes, it is usually rapid. They often develop a low grade pneumonia and die in a few days. A number of my patients with bone involvement have developed cerebral metastases, with death in a very short period, though they have been perfectly comfortable up to the occurrence of this accident.

The following is an example of such palliation. The patient, a woman of 48, came to my clinic on crutches on February 1, 1925. She had had an amputation of the breast in May, 1924. The growth was evidently a fairly extensive one, and the evi-

ilium. Radiation was immediately begun over the pelvis, 160 K.V., 0.5 mm. zinc plus 1 mm. aluminum filters, 40 cm. distance, giving about 80 per cent of an erythema. The treatments were given, as usual, about two weeks apart. She had no improvement for two months, but on March 30 she reported that she had no pain, and that she could lie on the right side. Crutches were abandoned, and she was taking no sedative medicine. She was doing her housework, and was gaining weight. In 1928 she complained of pain in the right shoulder, and X-ray examination showed involvement of the scapula, clavicle, and the upper end of the humerus on the left side (Fig. 3), and there was some evidence of involvement of the ribs on the right. Radiation of these areas checked

her pain. On May 1, 1928, she fell and broke her radius, which healed promptly. There was no evidence that this was a pathologic fracture. From time to time the pelvic condition was radiated, and there seemed

back to her work and live in fair comfort, gaining weight, and feeling well for three years and four months, when she died suddenly from a cerebral lesion. My records show a number of similar palliations, some



Fig. 2. Roentgenogram made February 17, 1927, showing repair in bones of the pelvis. Same case as shown in Figure 1.

to be a certain amount of ossification taking place in the old areas, which were almost free of bone, as the cuts will show (Fig. 2). During 1928 she was radiated chiefly to the shoulder—the pelvis and the hip gave her no pain. On May 11 she came in and reported that she had a little pain in the right ear, but otherwise was very well. She died suddenly on June 6, 1928, with a cerebral involvement, having been sick only a few days.

This was a case of a woman palliated for over three years. Her condition was so bad that she was walking on crutches and taking a considerable amount of narcotics. After a few radiation exposures she was able to go

longer, some shorter, including one with a moderate paraplegia who for a year after treatment was able to walk without support.

Another example of prolonged palliation is a case of carcinoma of the breast. This woman was admitted to my clinic on July 21, 1925, the referring surgeon saying that she had an extensive carcinoma, with much involvement of the axillary nodes, and that she should have heavy radiation, if possible. Treatment was begun with our usual technic of about 75 to 80 per cent of an erythema dose, at 160 K.V., 0.5 mm. zinc and 1 mm. aluminum filters. During 1926 the patient was very well and gained in weight. In July, 1927, she was reported as all right, and had



Fig. 3. The shoulder lesion on February 2, 1928. Same case as shown in Figures 1 and 2.

gained several pounds. In 1928 she began to cough, but there was no radiological evidence of recurrence. Shortly after this she was told by a physician that she had a carcinoma involving the entire lung. An X-ray film taken on February 3, 1930, showed that the patient's lung condition had greatly improved since the radiographs of September, 1929, and films taken on September 16, 1930, again reported some improvement in the lung condition. Despite the lung involvement in 1929 the patient gained weight under renewed radiation, and reported on January 3 that she had gained 12 pounds in the last three or four months. She was, however, short of breath. Radiation was changed from the lower voltage to 200 K.V., 8 ma., 50 cm. distance, and 60 minutes exposure with 0.5 mm. copper and 1 mm. aluminum filters. This is about 600 r-units. Under this treatment she continued to improve. At her last appearance, November 11, 1930, she was so short of breath that she was advised not to take any more treatments.

This is a record of an extremely advanced, hopeless case of carcinoma which survived in fair comfort a little less than five years.

An example of an unexpected palliation of a sarcoma of the pelvis follows. The patient was a woman 43 years of age, who had had pain in her left hip for several months. On examination there was found to be a large palpable mass which involved the inner surface of the left ilium. The iliac muscle was pushed up over the tumor. Radiographs showed no attachment to the bone. Biopsy revealed a tumor composed of small cells with no bone formation. She came under my care on March 31, 1925. After two exposures the patient reported her pain was much diminished. She was radiated fifteen times during 1925, the doses being about 80 per cent of an erythema, 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, and 8 milliamperes. During 1926 she received thirteen treatments; in 1927, eight treatments, and in 1928, seven treatments. On March 25, 1929, the patient said that she had never felt so well. During all this period she had been at work, and had gained 22 pounds in 1926. In December, 1927, she was examined by the surgeon in whose care she had originally been, and he reported that she was in fine condition. The patient was last seen by me on May 21, 1929, when she repeated the above statement about feeling so well. She was told to come back in the Autumn, but failed to keep her appointment. On inquiry by a social service nurse it was found that she had died very suddenly on June 29, whereas on May 21 she had felt extremely well. No explanation could be obtained for this death. It might have been a cerebral metastasis or any one of the complications which may occur in conjunction with malignant growths, but there was certainly no local return.

An example of prolonged palliation in a case of carcinoma of the breast is the fol-

lowing. A woman 48 years of age was referred to me for treatment for a large fibromyoma of the uterus reaching the fundus. As she had high blood pressure and headache, it was thought wiser not to operate on her. She received eight X-ray treatments, at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, 8 ma., and 15 to 20 minutes. This checked her periods; the myoma shrank down, and her pressure symptoms were entirely relieved. About the time this treatment was finished, some two months after she came to me, she called attention to her breast, and I found that she had a carcinoma with axillary nodes. She was operated on promptly. She developed a recurrence in the pectoral region, above the level of the axilla, six months later, and when seen by her surgeon, he regarded her as inoperable. There were also some enlarged nodes in the supraclavicular region. A roentgenogram at this time showed there were no definite areas of infiltration in the lung, but evidence of considerable pleural thickening at the site of the swelling. At this time she consulted Dr. Burton Lee of the Memorial Hospital, in New York, who advised the radium pack, insertion of gold needles in the nodule in the anterior axillary region, and treatment of the mass in the other axilla by the insertion of platinum needles. This the patient refused, preferring to take X-ray treatment. Exposures were then given of the same type as mentioned above, but somewhat heavier, reaching about 90 per cent of an erythema dose—at one time she did receive an erythema. These were repeated about every two weeks with intervals of rest, and in 1926, a year after the first operation, she had marked edema, with distinct nodes above the left clavicle, and the left arm began to swell. Radiation was continued, and in June, 1927, I had a note saying that she was in fine condition. There was some slight swelling of the left arm; the mass in the pectoral region had disappeared, as well as the nodes. The nodes

above the clavicle were not palpable. The mass in the right axilla had disappeared entirely under radiation of that region. Following January 21, 1928, that is, three years after her operation, she showed no evidence of carcinoma. On November 20, 1930, she had no evidence of any trouble except the swelling of the left arm, with a good deal of puffiness above the left clavicle. The nodes in that region could not be definitely made out. There was nothing to feel in the right axilla.

Here is a patient who was seen by three surgeons, all of whom believed she had a recurrence, and yet that recurrence disappeared under radiation of a very moderate voltage and quantity, and the patient was apparently in perfect health five years after her operation.

A highly sensitive tumor may disappear with very little radiation. A patient, male, 34 years of age, was referred to me by a surgeon on account of a very large abdominal tumor, the size of a pregnancy about the eighth month. The patient reported that his left breast had been very much swollen a year before, but under local treatment this swelling disappeared in two weeks. After this he noticed the abdominal tumor. At the time of examination this tumor filled the whole abdomen, was smooth, elastic, and not very firm. On physical examination the left testicle was found to be missing, and the patient stated that the tumor had begun on the left side. The man was rather pale, but otherwise nothing was found on physical examination. Biopsy was refused, but the growth was probably a seminoma. The patient received three heavy doses of X-ray, one on the right side of the abdomen, one on the left, and one on the left hip. These were just sub-erythemas. Two were given at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum filters, and one at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum filters. Within a short time after these treatments, the tumor disappeared. A month after the



man was first seen he had gained three pounds; two months later he had gained six and a half pounds more. After this, at monthly intervals, the patient received moderate doses of X-ray at 190 K.V., with 0.5 mm. copper filter. The doses were about 80 per cent of an erythema, and were given with the idea of preventing the possible return of the tumor. We heard from him last on February 24, 1930, that is, five years after his first treatment, and he reported that he was in perfect health. The value of the report suffers from the fact that no biopsy was done, as the tumor was so large that the competent surgeon who saw him first thought he was not justified in doing a laparotomy merely to get a specimen. Presumably the growth was a seminoma of the testicle, which is known to be highly sensitive to radiation. The point is that at no time was this man given extremely heavy doses, except the first three treatments, after which the tumor disappeared.

Another interesting case is that of a female child 21 months old. The patient was explored in December, 1924, because of an enormous tumor which filled the whole abdomen. The tumor was found to be inoperable, and unfortunately the surgeon took no biopsy, considering the child's condition to be too desperate to take any risks of prolonging the operation. The growth was probably a neuroblastoma, as such growths are sensitive. At this time there was moderate paraplegia, apparently due to pressure from the tumor. Radiation was begun, about 300 r-units, at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum, on January 13, 1925, and repeated at intervals of about two weeks. The child began to show distinct improvement five months after the first radiation. For three months no treatment was given, and then it was begun again and carried on at about monthly intervals, the doses being about 400 r-units. During the following year fourteen treatments were given. The year after that, eight; the

next year, six; the next year, only three, and this year, only two. A year after the treatment was begun the child was much better, and the tumor was smaller. Eight months later she was reported as very well. Nine months later the tumor mass began to grow, and radiation was given more frequently. On May 22, 1928, that is, two years and four months after the treatment was begun, there is a note that the child was in fair condition and the mass smaller than at first. On November 26, 1928, the records say the child was in good shape, the mass was smaller, and the condition excellent. On February 18, 1930, came a note saying the child was in good condition. I saw her on November 18, 1930. No tumor mass was palpable. The child looks like a normal child of six years of age, bright and intelligent. Incidentally, she walks perfectly at the present time.

Another example of palliation in a radio-sensitive tumor was a male 46 years of age, who had a large retroperitoneal lymphosarcoma, the diagnosis having been made by biopsy. He was referred to me on October 13, 1925. Treatment was begun with moderate voltage X-ray, about 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, giving about 400 r-units per dose, and using various portals to radiate the large mass in the abdomen. The treatments were given at about two-week intervals at first, and then less frequently. In 1927 he received only five treatments, and in 1928 only two. In 1929 he was examined by the surgeon who referred him to me, and was found to have no evidence of any trouble. On September 25, 1930, that is, about five years after his first treatment, he reported that he had been entirely well until about three weeks before, when he had become short of breath and weak. Examination showed the spleen to be very much enlarged, but there were no other nodules. The patient is still under treatment, but it is evident that return of the growth has begun. Nevertheless, here is

a five-year palliation with moderate X-ray dosage.

I feel very strongly from the study of individual patients, though I cannot demonstrate from a large amount of material, that this technic of handling advanced and hopeless mammary carcinoma, even though it does not necessarily prolong life, brings a great deal of comfort to the patient. How difficult it is to judge these matters is well illustrated by the treatment of myelogenous leukemia. A number of writers have stated that radiation does not prolong the average life of these patients. Nevertheless, I have a number of patients with leukemia, who, when I first saw them, were moribund, either because they had been treated improperly or because a diagnosis had never been made. Some of these patients had a hemorrhagic condition with large nodules in the skin and an enormous number of leukocytes—sometimes up to a million, with great destruction of the red cells. In a month or two they were back at work, the spleen reduced to almost normal dimensions, the hemorrhagic diathesis stopped, and they have remained in this condition for three or four years. Now certainly these patients would have died within a few weeks if not treated, so that I cannot agree with those who say that life is not prolonged. It may be that in a large series no great average prolongation of life is observed, but the individual case may show a remarkable capacity to come back. The physician does not refuse to treat cardiac and nephritic patients, even though he cannot cure the lesion. The main thing is to get the patients adapted to the physical limitations which the disease imposes on them and make them useful within these limits, even though the lesion may remain unchanged so far as anatomical conditions go.

In addition to the purely scientific aspect of all this material, the economic question of radiation plays a fairly important part. Inasmuch as the average income of a citi-

zen of the United States is somewhat under \$2,000 a year, it is obvious that the average cancer patient cannot afford high-priced treatments, so we must make every effort to render such radiation reasonable in price. This implies a large amount of material, handled in an efficient and business-like way, so as to reduce overhead costs as much as possible. From the cases cited you will see that many of them have been treated with low voltages, not above 160 kilovolts. Under these conditions even the inefficient X-ray tubes which we now possess for therapeutic purposes last six months or more if used eight hours a day. The tube cost per patient is therefore low. Experimental tubes have been made which have four or five times this life, and the Radiological Society should make every effort to see that these tubes come on the market as quickly as possible.

On the other hand, there is a certain amount of physical and clinical evidence which points to the necessity for a change in the type of our radiation if the best results are to be obtained. The biological experiments which Regaud made many years ago have not excited very much interest in this country. These furnished the demonstration that sterilization doses, using the testicle as biological material, are most efficient when they are given as a divided dose on successive days rather than as the single huge exposure originally recommended by German workers. In addition, Regaud showed that the use of highly filtered X-ray given for long periods was more effective than shorter doses. The combination of these principles is seen in the current practice at the Curie Institute, where carcinomas of the oral cavity are treated with exposures of four or five hours a day for from ten days to two weeks, giving a total of 7,000 or 8,000 r-units. Under these conditions a severe erythema is produced, but it does not as a rule go to blistering, the lesion heals quickly, the skin remains soft, and the vas-

# ABSORPTION MEASUREMENTS OF THE X-RAY GENERAL RADIATION<sup>1</sup>

By LAURISTON S. TAYLOR, WASHINGTON, D. C.

*Abstract.*—Studied as a means for indicating the quality of the radiation, copper absorption curves for heterogeneous X-rays were obtained, using a standard and two thimble ionization chambers. With the standard air chamber, logarithmic absorption curves were not found to become straight for filters up to 3 mm. in thickness—indicating a gradual elimination of the longer wave lengths. With thimble chambers, owing presumably to errors from the chamber “wall effect,” the curves were non-linear only up to 1 mm. thickness of filter.

Half value layers and effective wave lengths derived from the three sets of results were compared. The “effective wave length” as

derived from the slope of the absorption curve and the “half value layer” are about equally sensitive to changes in quality, at least up to 3 mm. thickness of filter. As should be expected, effective wave lengths thus obtained are always longer than those obtained by Duane’s finite filter method and, being less dependent upon the particular instrument used in the measurements, are, therefore, more consistent.

On the basis of the effective wave length determinations it is found that, contrary to the accepted views, the greater part of the highly filtered energy is not concentrated in the tungsten K lines.

## I. INTRODUCTION

IN connection with the proper control of X-radiation in its various applications, reliable and relatively convenient means of measuring the radiant energy is the first necessity. This part of the problem seems to be satisfactorily solved by observing proper care in the design and use of the ionization chamber. The Bureau has, therefore, announced its completion of a standard ionization chamber.<sup>2</sup> The next project on this program is the study of possible methods of determining “quality” of radiation. The accuracy with which it is necessary to describe the quality depends, of course, upon the particular use to which the radiation is put. In radiological practice an accuracy of 3 to 4 per cent may be sufficient, whereas in precise physical experiments the accuracy should be better, as indicated, for example, in the recent papers by Compton,<sup>3</sup> and Crowther and Bond.<sup>4</sup>

In the radiological field recent work by Pohle and Barnes,<sup>5</sup> Quimby,<sup>6</sup> and Burby and Barry<sup>7</sup> has shown large discrepancies in the qualities of the different X-ray beams as measured by different methods. Moreover, Quimby showed that three beams having the same “quality,” according to some Method A, had radically different “qualities” according to another Method B. It thus appeared desirable to make a fairly comprehensive study of available methods and the devices used in applying them.

Inasmuch as a beam of X-rays may cover a range of wave lengths which are unequally effective in producing the results sought, next in importance to measuring the total energy is that of determining the distribution of the energy among the wave lengths present. A direct measurement of spectral energy distribution is the most reliable and satisfactory way of describing the quality of the radiation, but this is so difficult and cumbersome that the method eliminates itself from the field of practical applications.

<sup>1</sup>Reprinted from Bureau of Standards Journal of Research, Research Paper No. 212, September, 1930.

<sup>2</sup>RADIOLOGY, April, 1930, XIV, 416; Am. Jour. Roentgenol. and Rad. Ther., 1930, XXIII, 316.

<sup>3</sup>A. H. Compton, Phil. Mag., 1929, VIII, 931.

<sup>4</sup>J. C. Crowther and W. N. Bond, Phil. Mag., 1928, VI, 401.

<sup>5</sup>E. A. Pohle and J. M. Barnes, RADIOLOGY, 1928, X, 300.

<sup>6</sup>E. H. Quimby, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 275.

<sup>7</sup>J. J. Burby and M. W. Barry, RADIOLOGY, 1929, XII, 275.

Fairly sound substitute methods of greater utility have been based on the degree of absorption of the total energy by filters of standard materials (copper, silver, alumi-

In using such data to determine minimum wave length,<sup>8</sup> it is necessary to extrapolate the curves to zero energy by starting at some point well up on the established curve,

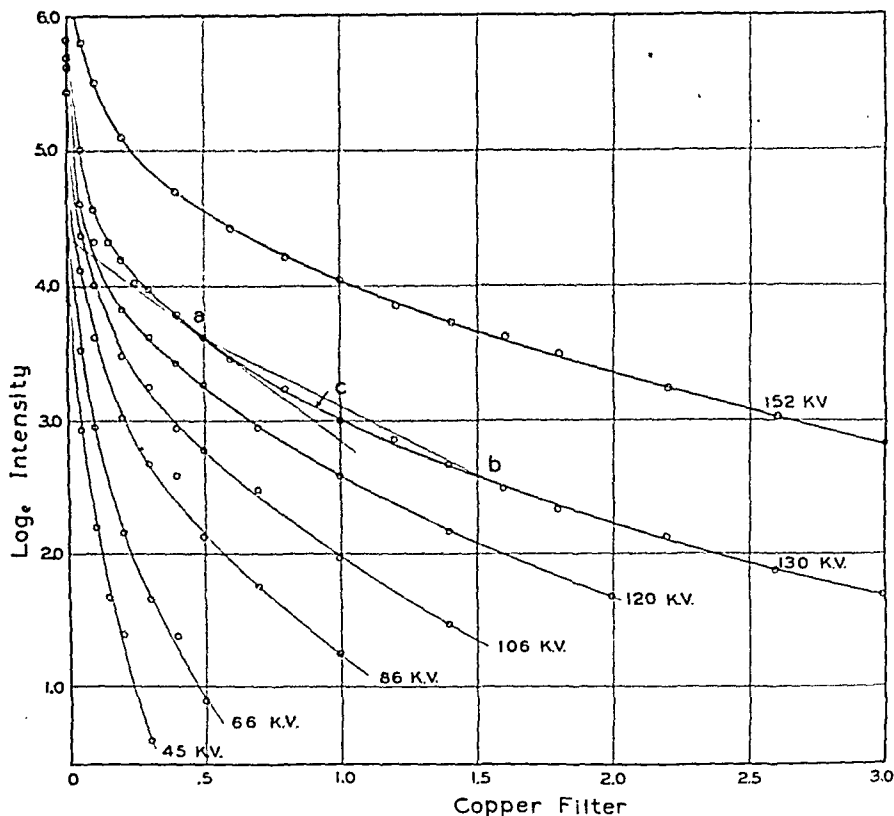


Fig. 1. Copper absorption curves made with standard air ionization chamber for practically constant voltage X-rays.

num, etc.), knowledge of the incident radiation being inferred from the absorption measurements of various filter thicknesses.

Even if the ionization spectrometer method of mapping the spectral radiation were not so difficult and cumbersome under present conditions, it would still be far from an ideal method owing to the many conditions involved, some of which are not well understood. The more common forms of the X-ray spectrograph as substitute for the ionization spectrometer are inadequate, for, due to such factors as X-ray scattering, photographic halation and spectral sensitivity of the emulsion, a simple density curve of the photographic plate may be very misleading.

which, of course, makes for very uncertain conclusions.

With these facts in mind the best method, for practical purposes, for arriving at the quality of any given X-ray beam seems to be that involving direct absorption measurements.

In deep therapy wave length ranges, Duane has shown that absorption measurements in copper are well suited for describing the quality.<sup>9</sup> In the superficial therapy range, either copper or aluminum absorption measurements<sup>10</sup> may be used; and, in

<sup>8</sup>A. Mutscheller, *RADIOLOGY*, 1929, XII, 283.

<sup>9</sup>William Duane, *Am. Jour. Roentgenol.*, 1922, IX, 167.

<sup>10</sup>William Duane, *Am. Jour. Roentgenol. and Rad. Ther.*, 1928, XX, 241.

The effective wave length as defined by Duane<sup>23</sup> is "the wave length of monochromatic radiation that would produce the same effect (readings of the instruments employed, etc.) that the actual radiation produces." His method of measurement con-

ly above and below the filter for which the radiation quality is desired. The absorption coefficient and corresponding  $\lambda_e$  is then obtained from the difference of the logarithms of these two intensity measurements, it being assumed that this absorption coefficient

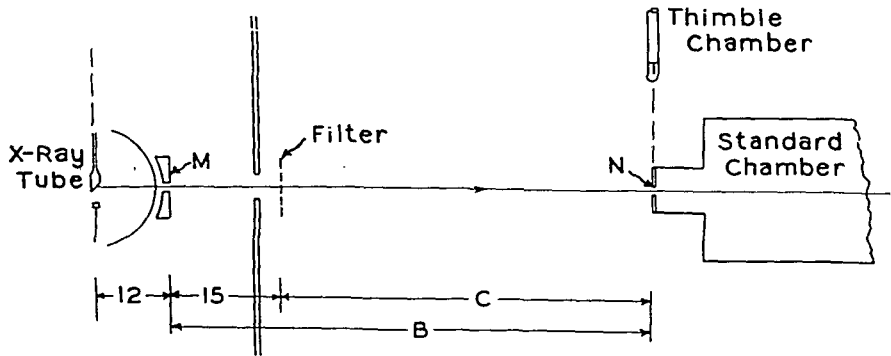


Fig. 2. Diagram of X-ray tube-filter-ionization chamber system.

sists in determining the percentage transmission of the given filter for the given radiation, then determining  $\lambda_e$  from previously constructed calibration curves, as obtained from the absorption law indicated in Equations (2) and (3).

The so-called "true effective wave length" is independent of any given filter thickness; and, in that one other factor is thus eliminated from its determination, it is physically a more desirable way to express the quantity sought. For its determination, a logarithmic absorption curve is established with a series of filters of increasing thickness and the slope at the point in question gives directly the composite absorption coefficient  $\mu$ . From monochromatic wave length absorption curves or Richtmyer's formula (Equation (3a)) may thus be determined, as the true effective wave length  $\lambda_e$ , the single wave length which has the same absorption coefficient.

A "bracket" method for obtaining  $\lambda_e$  may also be used wherein two intensity measurements are made for filter thicknesses equal-

is the same as that corresponding to the intermediate filter. Such a method, while nearer the tangent method (true  $\lambda_e$ ) than Duane's, does not make full allowance for the curvature of the logarithmic absorption curve between the points taken.

The bracket method is exactly the same as Duane's method as far as the operational procedure is concerned, except that the radiation for which  $\lambda_e$  is determined corresponds more nearly to that of the intermediate filtration instead of the smaller filtration. By Duane's method the ratio of the two intensities  $(E')/(E'')$  for filtrations  $x'$  and  $x''$  is said to give  $\lambda_e$  for the filtration  $x'$  whereas the bracket method gives  $\lambda_e$  for a filtration close to  $(x' + x'')/2$ . As shown later, the difference between the two varies according to the range in which the measurements are applied, and may be neglected for many practical purposes.

In Duane's earlier work he specified the use of 1 mm. of copper for obtaining the effective wave length. The use of such a large filter-difference will give reasonably consistent agreement with the true  $\lambda_e$  only

<sup>23</sup>William Duane, Am. Jour. Roentgenol. and Rad. Ther., 1928, XX, 241.

for very high filtrations as shown in Table II and when used according to the bracket method (Equation (8)). For lower filtrations the differences between the two methods increases. In later work he specified the use of 0.25 mm. filter separation, thus in-

heterogeneous X-ray beam was to measure the absorption by a series of filters of some material and then determine from the absorption curve the thickness of that material which would reduce the intensity of the given beam to one-half its initial value. If,

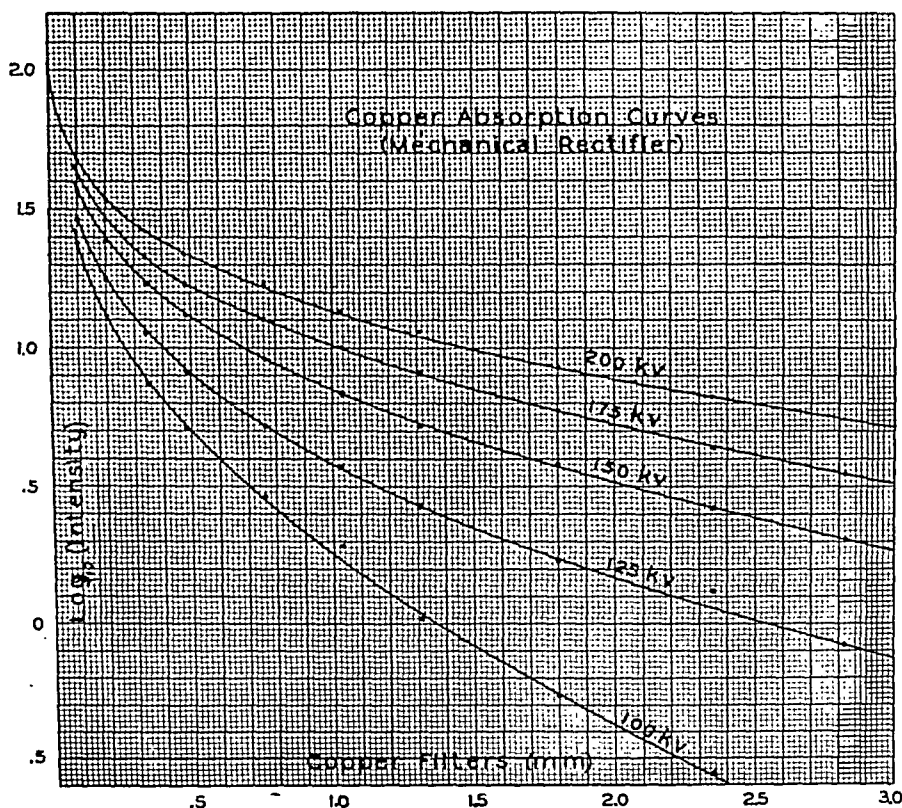


Fig. 3. Copper absorption curves made for mechanically rectified voltage.

creasing considerably the range over which  $\lambda_e$  might be determined with fair agreement with the other method (true  $\lambda_e$ ).

Duane also indicated at the time that small errors in the measurement of filter thickness may cause an appreciable error in the determination of  $\lambda_e$  by his method. The effect on  $\lambda_e$  of errors in thickness will, of course, be greater for the method using 0.25 mm. filter separation than for the 1 mm. method. In the case of obtaining  $\lambda_e$  from a complete absorption curve such errors are averaged out.

(B) *Half Value Layer*.—One of the earliest methods of describing the quality of a

for example, a beam has an intensity of  $E_{F1}$  after passing through a filter of thickness  $x_1$ , and  $E_{F2}$  is the half-intensity ( $E_{F1}/2$ ) after passing through a filter  $x_1 + x_2$ , then  $x_2$  is the half value layer of the particular material for that radiation which has passed through  $x_1$ . While then the quality is expressed by the effective wave length as determined by a given thickness of filter of given material, the half value method expresses the quality in terms of the thickness of filter (of given material) required to reduce the intensity by a given amount (one-half).

Obviously, the shorter the effective wave

length of the given radiation, the thicker this half value layer of filtering material must be. Inasmuch, therefore, as the composite absorption coefficient  $\mu$  of Equation (4) varies with the thickness  $x$  of the added filter, there is no simple direct quantitative relation connecting effective wave length with half value layer.

Comparing the half value layer and effective wave length method, the latter has the advantage in that it presents a clearer physical picture of the radiation quality.

In roentgenological practice, the voltage wave forms are usually of two general types, being either approximately constant or approximating a sine wave; and the target material is always tungsten. Here the half value method has served as a useful approximation for expressing the radiation quality. However, as a particular example, it is unsafe to rely on this method for comparing qualities of two radiations, one excited by constant and the other by a fluctuating voltage. Quimby<sup>24</sup> made a detailed study of the qualities of various radiations, all having the same half value layer of copper, and found large differences among them.

The inset (*A*) in Figure 5 shows a plot of the half value layer taken from the absorption curve in Figure 5, for filtrations as high as 1.6 mm. of copper. Investigations cited<sup>25</sup> have indicated that such a curve would be different for each voltage wave form applied to the tube.

(*C*) *Average Wave Length*.—This method was proposed by Mutscheller<sup>26</sup> several years ago. It follows the true effective wave length method in that from the tangent to a heterogeneous radiation absorption curve a coefficient of absorption is determined from Richtmyer's tables with which the corresponding monochromatic wave length is identified. He definitely divides his meas-

urements into two classes, those for the portion of the absorption curve from zero to the "homogeneity filter"<sup>27</sup> and those beyond this point.

According to the results presented in this paper there can be no "homogeneity filter," strictly speaking. Practically a filtration may be reached beyond which the radiation quality changes comparatively little—the absorption curve approaching linearity.

In most of his published absorption curves he shows such linearity above about 0.5 mm. copper filtration, indicating the attainment of effectively homogeneous radiation. There is no evidence that such a condition should be rigidly true and it is not reached within the range of filtration (0 to 3 mm. Cu) used in this paper. It appears, therefore, that the average wave lengths so obtained in the region beyond the "homogeneity filter" are subject to errors larger than herein contained; that is, Mutscheller's method is that of the true effective wave length above but applied in the range where the errors are such as to render the results questionable. Applied in the region below the "homogeneity filter"—that is, for small filtrations—his method is identical with the so-called true effective wave length method.

### III. EXPERIMENTAL RESULTS

#### 1. Comparison of Different Ionization Chambers

In the development thus far we have dealt with ideal conditions wherein it has been considered possible to make direct energy measurements. However, in applying absorption measurements as an indication of the quality of a given X-ray beam, the ionization current produced by the beam is the quantity measured. The current per unit energy does not change rapidly with wave length, and for simplicity we will speak of this as energy, understanding, of course, that the measured ionization is pro-

<sup>24</sup>E. H. Quimby, *Am. Jour. Roentgenol. and Rad. Ther.*, 1929, XXI, 64.

<sup>25</sup>See Footnotes 5, 6, 7, and 29.

<sup>26</sup>A. Mutscheller, *RADIOLOGY*, May, 1924; October, 1924; April, 1929.

<sup>27</sup>E. A. Pohl, *RADIOLOGY*, 1928, X, 300.

portional to the energy absorbed from the beam by the air in the ionization chamber.

The results of absorption measurements made by a number of observers are not in close agreement; consequently the technic

erated at practically constant potential, as recently described. The diaphragming system<sup>29</sup> to limit the beam was in accordance with the necessary conditions to make an accurate determination of the effective in-

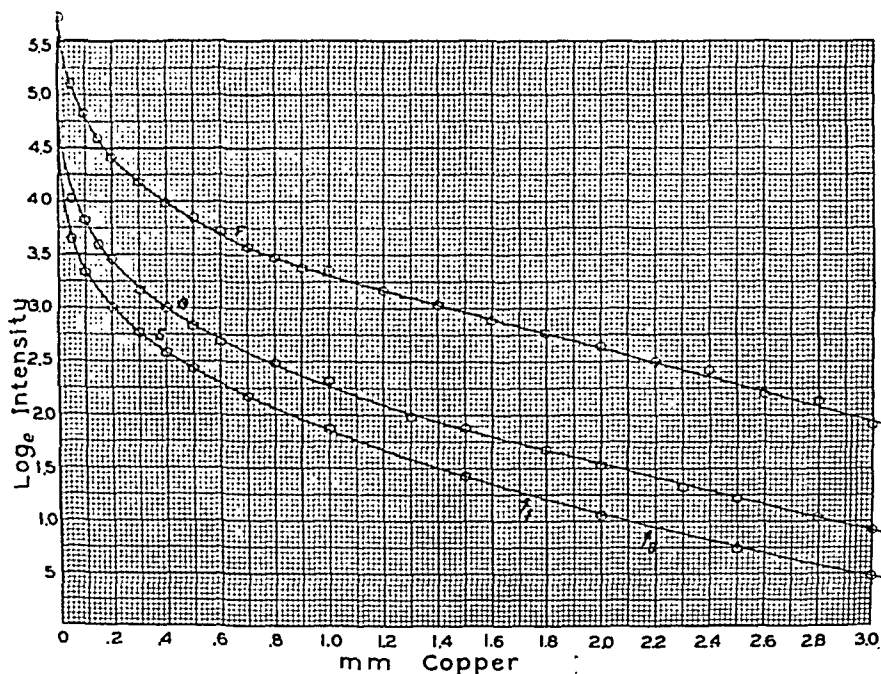


Fig. 4. Copper absorption curves made for 133 K.V. radiation, using three different chambers.

of making such measurements has been studied in the greater detail given here.

In some recent work at this laboratory a study was made of the calibration of the thimble ionization chambers against a standard air ionization chamber<sup>28</sup> in which it was brought out that there was a marked difference in the copper absorption curves for the same radiation when measured with several different thimble ionization chambers and the standard chamber.

In Figure 1 is shown a series of semilogarithmic copper absorption curves obtained by measuring the incident and transmitted intensities with the standard air ionization chamber. The tungsten X-ray tube was op-

tensity of the beam in roentgens.<sup>30</sup> When a thimble ionization chamber was used, it also was in accordance with previously described technic.<sup>31, 32</sup> The configuration of the system in Figure 2 shows the arrangement diagrammatically, and is self-explanatory.

For the curves shown in Figure 1 the diaphragms *M* and *N* each had a radius of 12 mm. and the interdiaphragm distance *B* was 65 centimeters. The filters were 15 cm. from *M*, thus making the distance *C* between filter and chamber diaphragm 50 centimeters. In taking these data the precision of observation for a single filter was about  $\pm 0.2$  per cent. The copper filters had a

<sup>28</sup>L. S. Taylor and G. Singer, Bureau of Standards Jour. of Research, 1930, IV (R. P. 169), 631.

<sup>29</sup>L. S. Taylor, Bureau of Standards Jour. of Research, 1929, II (R. P. 56), 771.

<sup>30</sup>L. S. Taylor, Bureau of Standards Jour. of Research, 1929, R. P. 119, p. 807.

<sup>31</sup>See Footnote 28.

<sup>32</sup>L. S. Taylor, RADIOLOGY, 1930, XIV, 551.



TABLE I

Filter	Standard		Friedrich		Glasser	
	$I_s$	$\log_e I_s$	$I_F$	$\log_e I_F$	$I_G$	$\log_e I_G$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	100.0	4.60	312.0	5.74	111.0	4.71
.05	38.4	3.65	164.0	5.10	55.7	4.01
.1	28.6	3.355	123.0	4.81	45.4	3.82
.15			99.0	4.58	35.7	3.58
.2	20.0	3.00	81.6	4.40	30.4	3.46
.25	(17.8)		72.6	4.285	(26.8)	
.3	16.1	2.78	66.3	4.194	23.8	3.16
.4	13.0	2.56	53.6	3.98	20.0	3.00
.5	11.5	2.44	48.1	3.87	17.2	2.84
.6			41.2	3.72	14.8	2.69
.7	8.70	2.16	35.6	3.57	(13.4)	
.8			32.5	3.48	12.1	2.495
.9			29.8	3.39		
1.0	6.49	1.87	28.8	3.36	10.2	2.315
1.2	(5.4)		23.6	3.16	(8.4)	
1.3					7.35	1.99
1.4			20.8	3.035		
1.5	4.11	1.43	(19.4)		6.62	1.89
1.6			18.0	2.89		
1.8			15.8	2.76	5.26	1.66
2.0	2.86	1.05	14.2	2.65	4.58	1.52
2.2			12.2	2.50		
2.3					3.72	1.31
2.4			11.2	2.42		
2.5	2.08	.733			3.36	1.21
2.6			9.0	2.20		
2.8			8.5	2.14	2.84	1.04
3.0	1.60	.469	6.7	1.90	2.56	.714

tested purity of 0.99998 and their thicknesses were uniform to within  $\pm 0.002$  millimeter. It is clearly evident that for the curves shown there is no straight portion up to a copper filtration of 3 mm., although it is apparent that they are asymptotically approaching a straight line. A large number of other such curves were obtained under varying conditions of the distance  $B$  and the diaphragms  $M$  and  $N$ , and all were exactly similar to those shown.

In order to be certain that no peculiarity of this system could be responsible for the form of these curves, I have obtained through the courtesy of Dr. Failla and of Dr. Quimby, of Memorial Hospital, New York City, the set of absorption curves for

tube potentials up to 200 K.V., shown in Figure 3. These were made some months previously with a thimble air wall ionization chamber differing slightly in construction from that used at the Bureau. Here also it is clearly evident that the absorption curves do not become straight.

Attention may also be called to a paper by Rump,<sup>33</sup> in which is given a similar series of absorption curves for potentials up to 150 K.V. (Fig. 5 in his article). Again, it is found that the curves are non-rectilinear. In view of the excellent agreement of these different workers there seems no question of the validity of the results.

The same type of copper-absorption meas-  
<sup>33</sup>W. Rump, Ztschr. f. Phys., 1927, XLIII, 254; 1927, XLIV, 396.

urement was next made with several thimble ionization chambers placed at various distances from the filter, but all for the same beam of radiation. It must be pointed out that the precision of observation with such

ing the filter position. For the standard ionization chamber no measurable effect was produced by moving the filter from 0.5 to 30 cm. from the entrant diaphragm. However, shifting the filter over the same range

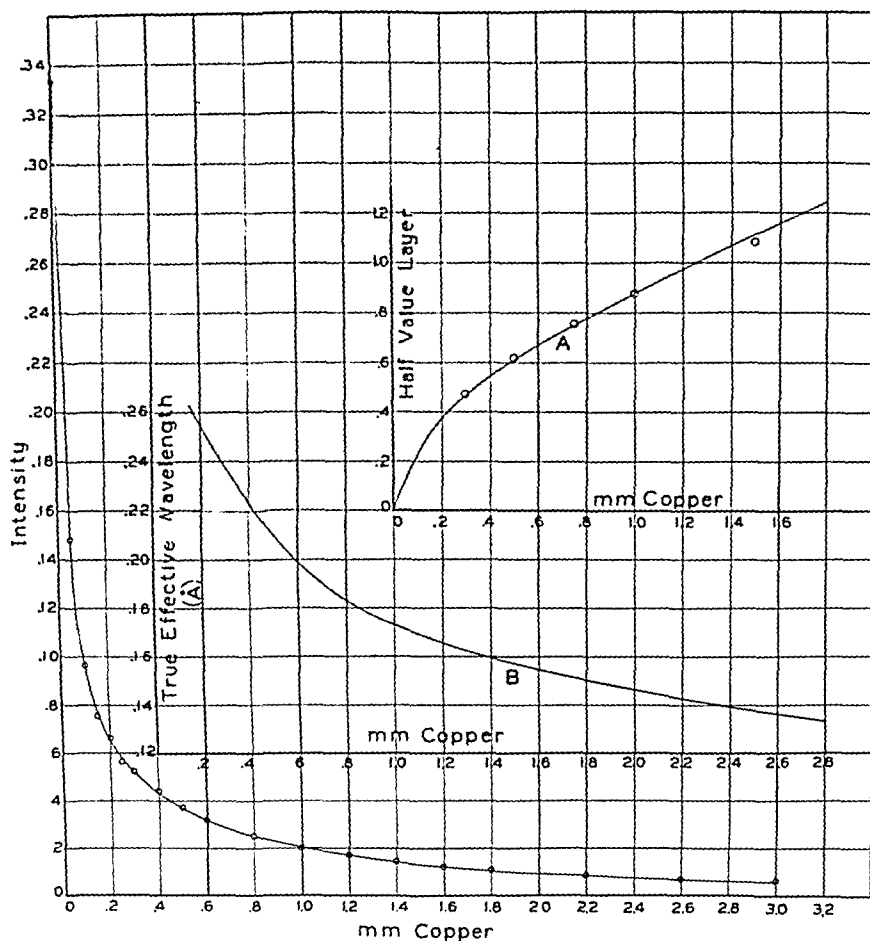


Fig. 5. Curves showing half value layer and true effective wave length obtained from the same absorption curve.

chambers is not as great as with a standard air chamber, and consequently we can not place the same reliance on the measurements made with them.

In order to be certain that the position of the ionization chamber with respect to the filter did not influence the measurements, a series of intensity readings were made, keeping the chamber fixed and chang-

ing the filter position. For the standard ionization chamber the measured intensity fell off steadily up to a distance of about 10 cm., where it reached a steady value. Consequently, all measurements with a thimble chamber were made at least 15 cm. from the filter.

In Figure 4 are shown three semilogarithmic absorption curves: *S*, obtained with a standard; *G*, with a Glasser thimble cham-

ber, and  $F$  with a Friedrich thimble chamber. The X-ray tube was operated at 133 K.V., D.C., for all. The standard chamber was set 45 cm. from the filter and the Glasser chamber and Friedrich chamber at about 15 centimeters.

The original data for these curves are given in Table I. The intensities  $I_F$  and  $I_G$ , as measured with the Friedrich and Glasser chambers, respectively, have each been corrected for a very small natural leakage. There was no measurable leakage in the standard chamber system. Half value layers obtained from these data were in good agreement with Holthusen's curves for the voltage used,<sup>34</sup> both measurements being made with a standard chamber.

It is seen that the curve obtained with the standard chamber does not become straight for filtration up to at least 3 mm. of copper. For Curve  $F$ , obtained with the Friedrich chamber, however, it is equally possible to pass a straight line or a slightly curved line through the points above 1 mm. filtration. Likewise for Curve  $G$ , obtained with the Glasser chamber, the points above 1.5 mm. could be joined by a straight or curved line, although the former is perhaps the better of the two. Straight lines are shown in both cases to illustrate a possible explanation for the absorption curves shown invariably by Mutscheller, his curves usually having been obtained with thimble chambers.

If now we measure the slopes of the curves, we find that  $F$  and  $G$  have straight portions with slopes  $-6.80$  and  $-6.28$ , respectively. The points marked  $f$  and  $g$  on the standard absorption curve have also these slopes of  $-6.80$  and  $-6.28$ , respectively. Thus for a given beam of X-rays we apparently find an absorption coefficient which varies considerably according to the technic used in measuring it. To attain uniformity the most logical consequence seems to be to discard the thimble chamber as a means for making precise measurements;

for, inasmuch as the open air chamber is free from wall effects and is the accepted standard, it is apparently the best available means for making absorption measurements of the general radiation.

Where, in practice, a thimble chamber is used in making precise quality measurements, care should be taken to correct for the wall effect.

## 2. Comparison of Quality Measurements

Having reviewed the methods of making quality measurements, we shall now compare the results obtained by applying each method to the same heterogeneous beam of X-rays generated by a practically constant potential source of voltage.

In order to better co-ordinate this comparison we shall refer all measurements of quality to those of the so-called true effective wave length without meaning to imply thereby that this method is preferable or necessarily the most correct. It is, however, less arbitrary than other methods.

Through the courtesy of Prof. H. Holthusen, of Hamburg, a family of curves was available, showing the relation between the half value layer in copper and the tube voltage (constant) for a series of filtered radiations. Half value layers were obtained from each of his curves at points corresponding to 130 K.V. and plotted as circles in the H. V. L. curve. (Inset A in Fig. 5.) The excellent agreement of our experimental results with Holthusen's shows the reliability of the H. V. L. method for constant potential, and gives further proof of the correctness of our above-mentioned experimental procedure.

We may now make a simple comparison of the effective wave length obtained by the slope and bracket methods. For example, if we were to take as the absorption coefficient the slope of the line joining the two points  $a$  and  $b$  on the absorption curve (Fig. 1), corresponding to filters of 0.5 and 1.5 mm. of copper, this would give the slope cor-

<sup>34</sup>H. Holthusen, *RADIOLOGY*, 1928, X, 292.

TABLE II

Filter	Slope $\mu$	True $\lambda_e$	Bracket $\lambda_e$		Equivalent filter	Duane $\lambda_e$	H. V. L. Cu
			$\mu$	$\lambda_e$			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm.	cm. <sup>-1</sup>	Å.	cm. <sup>-1</sup>	Å.	mm.	Å.	mm. 0.238
0.1							
.2	25.5	.256					
.25	22.8	.243					
.3	19.9	.230					.475
.4	17.5	.224				0.183	.56
.5	15.4	.207	28.0	0.262	0.15	.178	.62
.6	14.4	.202	16.6	.214	.45	.172	.68
.7	12.8	.192	13.8	.198	.6	.168	.73
.8	11.4	.184	12.2	.189	.7	.164	.79
.9	10.5	.178	11.3	.183	.8	.161	
1.0	9.86	.174	10.5	.178	.9	.158	.86
1.1	9.25	.170	9.6	.172	1.05		
1.2	8.64	.165	9.0	.168	1.15	.153	1.00
1.3	8.40	.163	8.5	.164	1.25		
1.4	7.94	.160	8.1	.161	1.37	.148	1.04
1.5			7.8	.158	1.45	.144	
1.6	7.53	.156					1.18
1.7			7.2	.153	1.8		
1.8	7.15	.153					
1.9			6.7	.148	1.9		
2.0	6.42	.146					
2.1			6.2	.144	2.1		
2.2	5.98	.142					
2.4	5.80	.140					
2.6	5.40	.136					
2.8	5.25	.134					

responding to a filtration of 0.9 mm. at the point *C* instead of at 1 millimeter. If the points 1 and 2 mm. were chosen instead, the effective wave length would be much more nearly the correct value at 1.5 millimeters. For small filtrations the error in the bracket type of measurement is considerable. Above a certain filtration the method may be sufficiently accurate for many purposes. It has the advantage of requiring but two measurements.

From Equation (8) the absorption coefficient  $\mu$  is given by

$$\mu = \frac{1}{x} \log_e \frac{(E')}{(E'')} \quad (10)$$

where  $(E')$  and  $(E'')$  are the intensities after passing through the two copper filters differing in thickness by  $x$  centimeter. If, for example, we wish to find  $\mu$  for 133 K.V.

radiation filtered through 1 mm. of copper, we have from Table I, Column 3,  $\log_e (E') = 2.44$  for filter 0.5, and  $\log_e (E'') = 1.43$  for filter 1.5 millimeters. This gives  $\mu = 10.1$  and  $\lambda_e = 0.174$  Å. Comparing this with the true effective wave length for 1 mm. copper filtration (Table IV, Column 3) we find a value of 0.169 Å. for the true effective wave length, a fairly good agreement.

A series of values of  $\lambda_e$  for 130 K.V. radiation obtained by the bracket method (where  $x = 1$  mm.) are given in Table II.

A summary of the absorption measurements is shown in Table II wherein all the calculations are taken from the absorption curve at 130 K.V. (Fig. 1). Column 2 gives the slope of the curve at points corresponding to the different thicknesses of

the copper filter indicated in Column 1. Since the curves were plotted with Napierian logarithms, Column 2 thus gives directly the coefficient of absorption  $\mu$  for each quality of radiation. Column 3 gives the corre-

curve, corresponding to a filter separation of 1 millimeter. The intermediate filtration of the two is that shown in Column 1. Column 5 gives the effective wave lengths corresponding to the absorption coefficients of

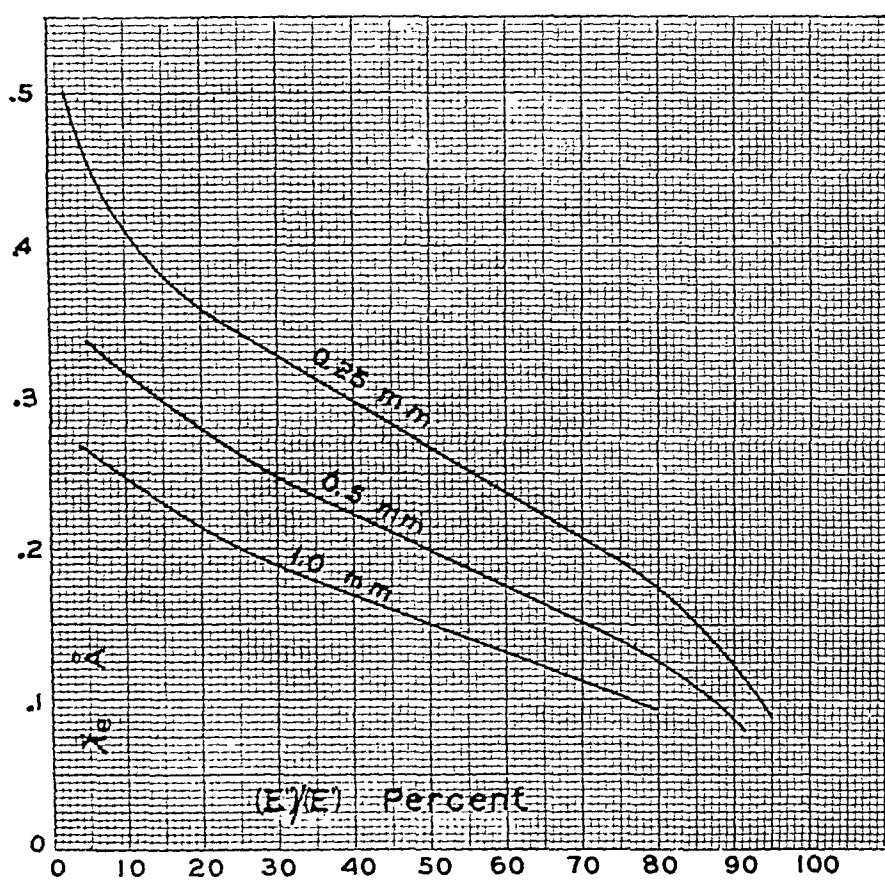


Fig. 6. Effective wave length as a function of the percentage transmission through given filters of finite thickness.

sponding true effective wave lengths when the values of  $\mu$  are put in Richtmyer's copper absorption coefficient curves for monochromatic radiation. From this it is seen that the effective wave length varies appreciably for filtrations up to 2.8 mm. at least. A plot of the effective wave lengths is shown in Inset B of Figure 5.

Column 4 gives the value of the absorption coefficient obtained by the "bracket" method (Sec. II, 2 (a)) wherein the coefficient is given by the slope of the line joining two points on the logarithmic absorption

Column 4, from which it is seen by comparison with Column 3 that, as should be expected, the values approach the same limit for higher filtrations. Column 6 gives the approximate filter thickness on the true absorption curve for the effective wave lengths of Column 5, thus indicating the divergence in terms of filter thickness. For example, consider a beam having an initial filtration of 0.6 mm. copper. Its true effective wave length is 0.202 Å., whereas that derived by the "bracket" method is 0.214 Å. and would correspond to a filtration of about 0.45 mm.

on the logarithmic absorption curve. Such a discrepancy shows at once that the bracket method, using a filter separation of 1 mm., is not satisfactory for obtaining effective wave lengths in close agreement with the true effective wave length except for higher filtrations.

Column 7 gives the effective wave lengths obtained by Duane's method, using a 1 mm. filter separation, from which it is seen that the difference between  $\lambda_e$ , as obtained by the slope of the curve and as obtained by Duane's method, is large over the whole range of filtrations used. Applying the same measurements, however, we obtain a fairly good measure of  $\lambda_e$  for the radiation corresponding to the average filtration. Thus for 0.7 mm. initial filtration, the true effective wave length is 0.192 Å.; by the 1 mm. bracket method, 0.198 Å., whereas by Duane's (1 mm.) method, 0.168 Å. When comparing Duane's effective wave length using 0.25 mm. copper with the true effective wave length, the differences are not large except for unfiltered or lightly filtered radiation.

From the practical standpoint we must not ignore the advantages of Duane's method. It requires but two intensity measurements with given filters and reference to a predetermined calibration curve; it is sufficiently accurate for many of the present-day medical needs.

The half value layers in copper for the same radiation are given in Column 8 and it

is seen that, throughout the entire length of the absorption curve, these are decreasing continuously at least up to an initial filtration of 1.6 millimeters. The data of Column 8 are plotted in Insert A of Figure 5. As pointed out in (II, 2 (c)), there can be no fixed relation between the half value layer and effective wave length except for strictly constant potential X-rays. Curves showing the relation between the two have been given by Neeff and Reisner<sup>35</sup> and others under different conditions, but none lead to any co-ordinated relationship.

Table III shows the results of determining the effective wave length of the unfiltered radiation by Duane's method, using both a standard (*S*) and a thimble (*F*) ionization chamber for the intensity measurements. Column 1 indicates the type of chamber used; Column 2 is the filter thickness used in the determination of  $\lambda_e$ ; Column 3 gives the percentage transmission of the respective filters for which are given the corresponding values of  $\lambda_e$  in Column 4, obtained from Duane's curves for effective wave lengths.

It is interesting to note, for lightly filtered radiation, how dependent is the measurement of  $\lambda_e$  on the type of ionization chamber used. For example, in the first case  $\lambda_e$  differs by 8.1 per cent for the two chambers, while the respective percentage transmis-

<sup>35</sup>T. C. Neeff and A. Reisner, *Strahlentherapie*, 1929, XXXII, 190.

TABLE III

Chamber	Filter	$E/E_0$	$\lambda_e$ (Duane)	Percentage difference $E/E_0$	Percentage difference $\lambda_e$	$\lambda_e$ calculated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	mm.	Per cent				
S	0.25 Cu	17.7	0.37	22.4	8.1	0.368
F	.25 Cu	23.3	.34			.343
S	1.0 Cu	6.5	.26	30.9	7.5	.263
F	1.0 Cu	9.4	.24			.234
S	2.0 Al	41.8	.47	11.6	4.2	.....
F	2.0 Al	47.3	.45			.....
S	4.0 Al	27.4	.41	15.1	2.5	.....
F	4.0 Al	32.3	.40			.....

tion coefficient  $\mu$  of the radiation by some means and from this the wave length of monochromatic radiation having the same  $\mu$ . For certain ranges Pohle and Barnes found that Duane's effective wave length curves

mined over the full range needed to determine  $\lambda_e$  for all the radiations used in X-ray therapy.

It seems reasonable, therefore, to recommend that the absorption coefficient in cop-

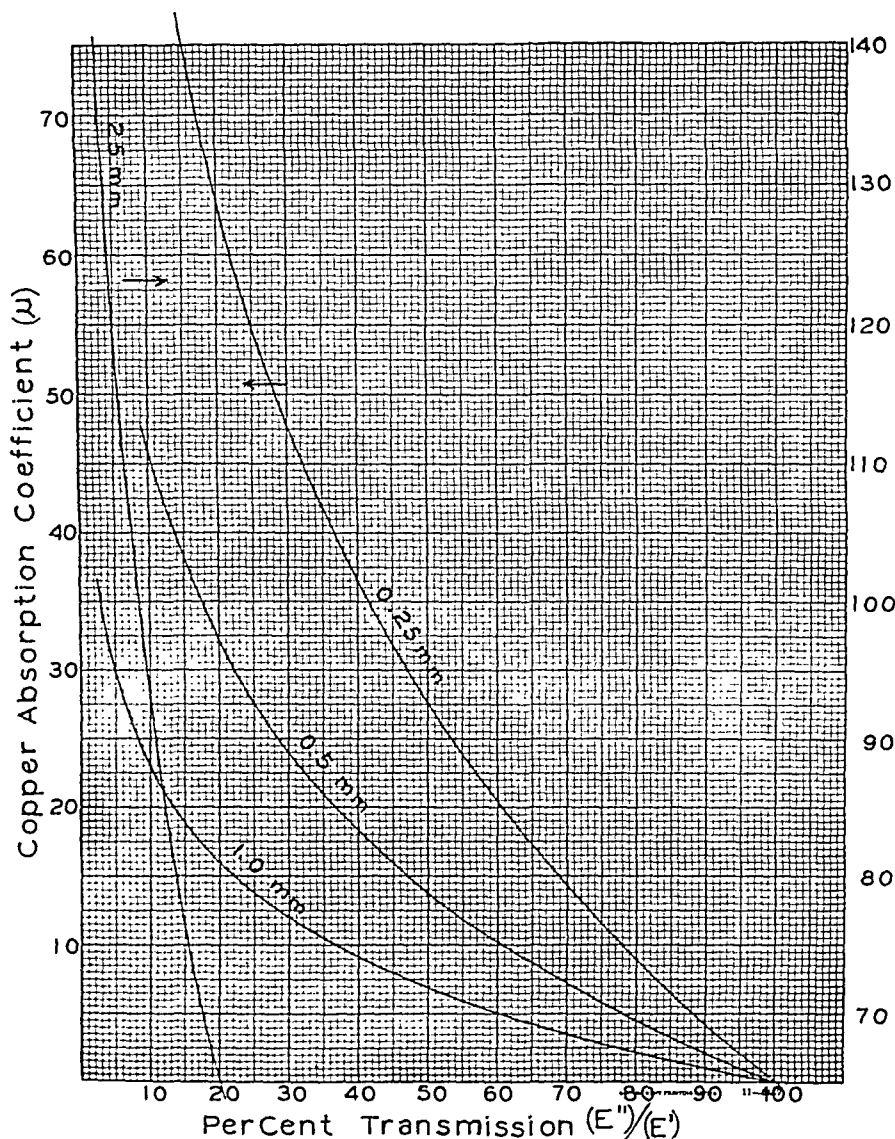


Fig. 7. Copper absorption coefficients as a function of the percentage transmission through given filters of finite thickness.

Note that the curve for 0.25 mm. filter is in two parts.

were inadequate, and consequently expressed  $\lambda_e$  in terms of the percentage transmission of a given filter—a physically undesirable procedure. The fact remains that at present the monochromatic wave length copper absorption coefficients have not been deter-

per or aluminum of a heterogeneous beam of X-rays be used alone to express the quality, stating the methods used in its determination. If desired at any future time, it is then a simple matter to express from available data the effective wave length in the

ranges where possible. Such a method would, for example, eliminate any confusion in Pohle and Barnes' tables.

As shown in (II, 1), the most accurate value of the composite absorption coefficient is obtained when using an infinitesimal filter thickness. The degree of agreement between this and one of the finite filter methods has been shown in Table II.

In practice,  $\mu$  may be determined (1) directly from the slope of the copper absorption curve, giving the true absorption coefficient; (2) by Duane's method, giving an approximate absorption coefficient, and (3) by the bracket method, giving a value in closer agreement with the true absorption coefficient. The first requires a series of measurements. The second and third require but two measurements and  $\mu$  is calculated from Equation (10).

For reference, Figure 7 gives curves for the absorption coefficient as a function of the percentage transmission of several thicknesses of filter which may be used in applying Methods 2 and 3, above. These apply for a filter of any material but care must be taken that the material and thickness are always specified.

#### V. SPECTRAL ENERGY DISTRIBUTION AS DERIVED FROM COPPER ABSORPTION MEASUREMENTS

We may now turn to one other application of the foregoing copper absorption measurements, namely, the determination of a qualitative picture of the energy distribution in a beam of filtered heterogeneous radiation without the use of a spectrometer.

The effect on an X-ray beam of adding successive layers of a filtering material (copper, for example) is to reduce the intensity of all incident wave lengths according to the absorption law expressed in Equations (3) and (3a). As seen from this equation, the greatest absorption occurs in the longer wave lengths, so that by increas-

ing the filter thickness the energy becomes relatively more and more concentrated in the shorter, more penetrating wave lengths.

If, to take a particular case as an example, a tungsten target X-ray tube be operated below the critical voltage (70 K.V.) at which the characteristic  $K$  series of lines appear, the effect of increased filtration is such that the maximum of the spectral energy distribution curve of the filtered radiation shifts steadily toward shorter wave lengths. It would be expected that for such conditions a logarithmic plot would approach asymptotically a straight line, the slope of which is the  $\mu$  for the short wave length limit. Since this would require that the remaining energy be practically zero, we would not expect the absorption curve to become straight for filtrations ordinarily used (0 to 3 mm. copper).

However, in the case of operating the same tube well above its critical voltage, for example, at 150 to 200 K.V., the  $K$  lines will be present and conditions altered. The effect now of increased filtration is again to reduce the energy at all wave lengths, the resulting energy distribution being dependent upon the voltage and filtration; but, in general, the energy transmitted through thick copper filters will consist of several practically monochromatic lines—the several  $K$  lines and the “end” radiation at the short wave length limit.

At present we have no very accurate data concerning the relative intensity of the  $K_\alpha$  lines in comparison with the continuous spectrum background. There will always be present a certain amount of this radiation of shorter and less easily absorbed wave lengths, and it is thus impossible to state in advance the expected form of the logarithmic copper absorption curves for such radiation after high filtration. Only if the amount of continuous radiation were negligible; compared with that of the line radiation, could it be expected that the absorption curve would become straight, thus indicat-



ing a constant absorption coefficient  $\mu$ . At tube potentials of the order of 150 K.V. it has been tacitly assumed by some workers that a large part of the spectral energy comes from the  $K\alpha$  lines of tungsten which appear at wave lengths of about 0.2 Å., thus accounting for a straight end to the absorption curve. However, such a distribution of energy, even in highly filtered radiation, is contrary to experience.

Having obtained values of  $\lambda_e$  for copper filtrations up to 3 mm. we see that the effective wave length of 150 K.V. radiation does not approach the wave lengths of the tungsten  $K\alpha$  lines which occur at about 0.208, 0.213, 0.184, and 0.179 Å., respectively. The nearest approach of  $\lambda_e$  to these wave lengths occurs for about 0.6 to 0.8 mm. of copper filter; whereas, for the maximum filtration used,  $\lambda_e$  was about 0.134 Ångström. This is a reasonable value of  $\lambda_e$ , since for the voltage used the minimum wave length  $\lambda_0$  of the spectrum is 0.095 Ångström. The fact that  $\lambda_e = 0.134$  Å. is nearer  $\lambda_0 = 0.095$  Å. than the wave length of the  $K$  lines gives further indication that the larger part of the energy passing through the filter is not that of the  $K$  lines, but that of the continuous spectrum background instead.

As a qualitative check of the above reasoning, we may refer to some approximate spectral energy distribution curves obtained by Duane<sup>3</sup> with an ionization spectrometer. The curve shown was made at 161 K.V. (constant potential) and 1 mm. of copper, and it is shown thereby that the greater part of the remaining energy apparently lies at shorter wave lengths than the first-order tungsten lines.

## VI. SUMMARY

1. A qualitative theory of copper absorption measurements shows that, for a known spectral energy distribution, an effective wave length may be determined which

is definitely related through known absorption laws to that distribution.

2. The logarithmic copper absorption curves for heterogeneous high voltage X-radiation do not become straight for filtrations up to 3 mm. copper when the measurements are made with a standard ionization chamber.

3. Absorption measurements, applied to the problem of describing the quality of a heterogeneous beam of X-rays, show (a) that measurements of the so-called "average wave length" of the radiation have no meaning as long as they are based strictly on the logarithmic absorption curve becoming straight for filtrations greater than the "homogeneity filter"; (b) the "half value layer" method of expressing quality is sensitive at least up to 1.6 mm. copper filtration but is readily reproducible only for strictly constant voltage applied to the X-ray tube; (c) the most logical expression of the "effective wave length" is obtained when using the absorption coefficient given by the slope of the logarithmic absorption curve. This is called the true effective wave length.

4. Duane's method for obtaining the effective wave length gives values consistently lower than the true effective wave length, although the difference is not great enough at higher filtrations to have any significance for most medical work. If this method is employed, the thickness of copper used in the measurement should be stated.

5. The bracket method for determining the effective wave length is more accurate than any other approximate method, but requires one more observation than the Duane method.

6. Absorption measurements made with the more common form of thimble ionization chamber are subject to error due to the chamber "wall effect." Such error is minimized in the true effective wave length method.

7. The absorption coefficient obtained with a standard thickness of copper (or alu-

minimum) is recommended as the simplest general method of describing the quality of a heterogeneous beam of X-rays for therapeutic uses. Due to a lack of monochromatic wave length absorption data over a sufficient range, it is impossible to extend the effective wave length method over the whole range of radiations encountered in X-ray therapy. Thus, for a perfectly general physical definition of quality, the "true" absorption coefficient obtained from the

slope of the absorption curve is recommended.

8. The effect on heterogeneous tungsten radiation of increasing the copper filtration is the concentration of the major part of the transmitted energy in wave lengths shorter than the *K* series of lines.

Recognition is due G. Singer, of this Laboratory, for having carried out the experimental part of this work.

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# COLOR CHANGES PRODUCED BY ROENTGEN RAYS IN SOME AQUEOUS SOLUTIONS

CONSIDERED FOR DOSAGE MEASUREMENTS AND FOR DETECTION OF EFFECTS OF RADIATION ON OTHER CHEMICAL COMPOUNDS

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CHEMICAL effects produced by roentgen radiation have been studied during the past years by several investigators. Changes have been produced in a number of compounds, as has been pointed out in a recent article by Clark and Pickett (1). As a rule, very minute quantities are changed chemically by the roentgen dose which can be applied in a reasonable length of time. It is, therefore, not surprising that some of the substances irradiated seem to have been unaffected. Whether no change at all took place, or whether the methods for detecting the change were not delicate enough, remains to be determined. The studies to be described here may lead to a delicate method for detecting chemical effects of the radiation and a method which may perhaps be applied to a great number of substances.

Our investigations were at first aimed mainly at finding a simple method for measuring roentgen-ray dosage. Considering that some color change might be found that would be satisfactory for this purpose, we started to investigate the effect of radiation on solutions of a number of chromatic substances.

Color changes produced by roentgen rays have long been utilized as a means of measuring radiation quantitatively. The Sabouraud-Noiré (2) dosimeter is based on this principle. Solids of fairly high average or effective atomic weights are used in this as well as in other similar dosimeters. Aqueous solutions should be better for two reasons: (a) water absorbs and scatters roentgen rays to about the same extent as tissues, and (b) the color change in solutions

can be measured accurately by means of colorimeters, or, still better, by spectrophotometers.

Fricke and Morse (3) have described how the oxidation of ferrous sulphate in a 0.8 N sulphuric acid solution can be used for measuring dosage, and we have used this method to find out how much roentgen radiation was absorbed in the different solutions we examined. The main practical objection to this method is that the amount of  $\text{FeSO}_4$  oxidized has to be determined in a rather complicated way. Recently Wyckoff and Baker (4) have found that the action of roentgen rays on Eder's solution [ $\text{HgCl}_2 \cdot (\text{NH}_4)_2 \text{C}_2\text{O}_4 \rightarrow \text{HgCl}$ ] may be utilized for measurements of dosage. It is, however, rather questionable whether this method can be made practical, though attempts in this direction have been made (5).

Fricke found that the amount of  $\text{FeSO}_4$  oxidized per cubic centimeter of solution was directly proportional to the dose, and independent of the concentration. The same relation was found by Clark and Pickett (1) to hold for the reduction of potassium nitrate to nitrite. We have obtained similar relations for tyrosine (5) and phenol. As very small amounts are changed it is evident that at least for certain compounds it is best and often necessary to use very dilute solutions in order that it may be possible to measure the effect of the radiation. We consequently used only substances which gave a strong color in weak solutions.

After some experimentation we decided that it was of advantage to use a tube 10 cm. long for the measurements of the color change, and that the solution in such a tube

should have a decided and easily measurable absorption band in the visible part of the spectrum before it was irradiated. The concentration for each substance had to be regulated to suit these conditions. The following were selected for a test: methylene

only one of the substances discussed here which showed a decided increase in absorption. Unfortunately, it is unstable in this concentration even when kept in the dark. It was studied rather thoroughly and shall, therefore, be mentioned again.

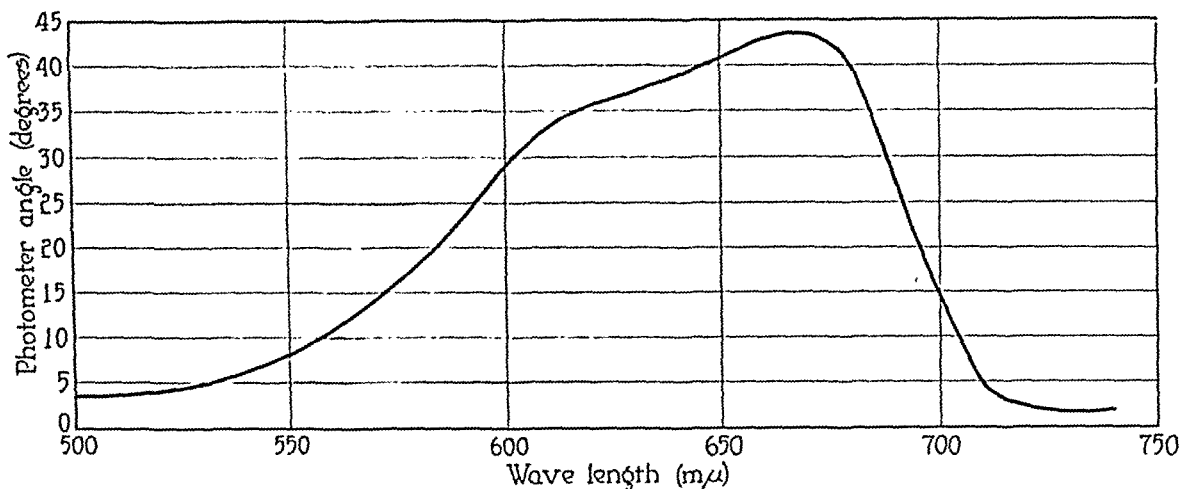


Fig. 1. Absorption curve for methylene blue.

blue, potassium dichromate, potassium permanganate, gentian violet, acid fuchsin, ferric ammonium citrate 1 per cent, cupric nitrate 1 per cent, nickelous chloride 1 per cent, and cobaltous chloride 1 per cent. The last four of these compounds had to be used in comparatively concentrated solutions and (probably as a consequence) showed no appreciable change after one hour of irradiation. Mercurochrome, erythrosine, and eosine did not seem to be especially influenced either. Gentian violet showed a definite decrease in absorption after irradiation (1 c.c. saturated ethyl alcohol solution in 10 liters  $H_2O$ ), but not as much as methylene blue. Acid fuchsin showed a decided reduction of the absorption band between 460 and 580 mμ. It also did not change as decidedly as a 0.00016 per cent aqueous solution of methylene blue, which will be considered in greater detail later. Neither did potassium dichromate prove to be as sensitive. Potassium permanganate in a 0.001 N solution was very sensitive to radiation. It is the

Before the results are discussed further it seems advisable to describe how the experiments were carried out. Radiation given off from a high voltage therapy tube was utilized while patients were being treated. The solutions were placed in specially made glass tubes. For some of the experiments the tubes were sealed off by a flame after about 20 c.c. of the solution had been poured in. These tubes measured 1.5 to 1.7 cm., inside diameter, and about 15 cm. in length, with a wall thickness of about 0.13 centimeter. For other experiments 50 c.c. of the solution were poured into glass tubes equipped with ground glass stoppers. These tubes measured 17–19 cm. in length, 2.3 cm. inside diameter, with a wall thickness of about 0.13 centimeter. For most of the experiments the glass was painted black so that no light could reach the solutions. The glass tubes were placed inside the container in which the roentgen tube was housed (an Acme-International tube stand), at a distance of about 60 cm. from the center of the

tube to the target. They were laid down all in the same position with the top away from the target and 1 cm. higher than the bottom. Usually one of the tubes was kept in a lead capsule and served as a control. In order to determine the amount of roentgen radiation absorbed by a weak solution in such glass containers per hour of radiation, some of them were filled with 0.001 N  $\text{FeSO}_4$  in 0.8 N  $\text{H}_2\text{SO}_4$ . The dose absorbed was measured in a manner similar to the one used by Morse and Fricke (3), using the value of 0.0027 mg.  $\text{FeSO}_4$  per c.c. oxidized by one kilo roentgen, which value was calculated from their data. Two hundred K.V., 30 ma., and no filter except the glass wall of the container were used. About 8 kilo roentgens were thus found to be the dose given the solution per hour. Independently of the absolute dose, this method gives a good comparison between the oxidation effect on  $\text{FeSO}_4$  and the other effects studied.

In order to determine quantitatively the light absorption of the solutions, a Bausch & Lomb spectrophotometer was used, consisting of a constant deviation spectrometer and a Marten's polarization photometer. An unirradiated sample of the solution was always measured immediately before or after the measurements were taken of a sample of the same solution which had been exposed to roentgen rays.

A 0.0002 molar solution of  $\text{KMnO}_4$  is strongly colored purple. It has a wide absorption band in the yellow, green, and blue, with a maximum at about 530 m $\mu$ . The band is so intense that it seemed quite black between 510 and 560 m $\mu$  when a 10 cm. absorption tube was used. A 5 cm. tube permitted fair readings and was, therefore, used instead for this particular solution. An exposure of 15 minutes to roentgen rays showed a decided effect, in that the absorption below 500 m $\mu$  increased to an extent that was easily measurable. The absorption towards longer wave lengths remained practically unchanged, however. The in-

creased absorption toward shorter wave lengths is due to a formation of  $\text{MnO}_2$  (7). This was the most sensitive reaction we found but it did not seem practical to use it, as the  $\text{KMnO}_4$  in such a weak solution is so unstable that it is changed to some extent even when kept in the dark.

Of all the substances tried, methylene blue seemed to be the most promising. It was used in different concentrations, and, of these, 0.0016 mg. per c.c. was the most favorable one when used in a 10 cm. absorption tube. Figure 1 gives the light absorption curve of this solution when the wave length measured in m $\mu$  is used as abscissa and the angle of the photometer is used as ordinate, 45° being complete absorption, and 0° no absorption. When the solution was irradiated the absorption was gradually reduced, but the shape of the curve was retained except in the green region of the spectrum. It seemed, therefore, unnecessary to take measurements at more than two or three wave lengths and it was decided to measure the amount of absorption quantitatively at 665, 620, and 520 m $\mu$ . The percentage of methylene blue disappearing (as indicated by the color) can be calculated by means of the formula,

$$\frac{C_1}{C_2} = \frac{\log T_2}{\log T_1};$$

where  $C_1$  and  $C_2$  refer to the concentration before and after irradiation, respectively, and  $T_1$  and  $T_2$  to the corresponding transmission.  $T = \tan \theta_1 \times \cot \theta_2$ ; where  $\theta_1$  refers to the angle of the polarization photometer between 0° and 45° and  $\theta_2$  the angle between 45° and 90° that gives a good

match. ( $T = \frac{I'}{I}$  where  $I$  = intensity of incident light;  $I'$  intensity after passing through the solution.) Table I gives the relation between the amount of radiation and the color change of two independent experiments. Column 1 gives the time of exposure to roentgen radiation; Columns 2, 3, and 4 the reading of the photometer for

TABLE I.—METHYLENE BLUE

Time of exposure (hrs.)	Photometric readings			Unchanged		
	at 520	620	665 mμ	% (mg. per c.c.)	Log	%
0.00	41.1	9.2	1.4	100	0.0016	2.00
0.38	40.7	11.8	3.1	79	0.00126	1.90
0.79	39.4	13.6	5.3	64	0.00102	1.81
1.31	38.7	18.3	10.7	45	0.00088	1.65
1.78	39.4	24.1	18.6	29	0.00046	1.46
2.21	39.8	26.2	20.6	27	0.00043	1.43
2.79	40.7	30.7	28.0	17	0.00027	1.23
0.00	41.7	10.2	1.8	100	0.0016	2.00
0.59	40.5	14.6	5.3	69	0.00110	1.84
1.02	40.1	18.8	10.2	50	0.00080	1.70
1.48	40.0	24.4	17.9	33	0.00053	1.52
2.07	40.1	28.6	24.8	22	0.00035	1.34
2.64	39.0	28.6	25.8	20	0.00032	1.30
3.17	40.5	37.6	38.6	7	0.00011	0.85
4.15	41.0	37.8	40.3	5	0.00008	0.70

wave lengths 520, 620, and 665 mμ, respectively; Column 5 the percentage of change calculated from the absorption at 665 mμ; Column 6 the concentration of the solution according to the color in mg. per c.c., and Column 7 the logarithm of the percentage of unchanged methylene blue. The percentage of change as a function of the time of exposure is shown graphically in Figure 2-A, which is drawn by inspection. It is evident from the curve that the change is not directly proportional to the dosage as is the case with FeSO<sub>4</sub>. If the logarithm of the percentage of methylene blue unchanged is plotted against the time of exposure the relation seems to be a straight line (Fig. 2-B) as far as the accuracy of the readings permit us to conclude. This is, of course, only a first approximation. This is the same type of relationship that has already been found to hold for the deactivation of trypsin (8) and for the oxidation of oxyhemoglobin to methemoglobin (9). We believe this is due to the formation of substances with little or no light absorption in the measured region, which are decomposed further by the roentgen radiation, thus competing with the methylene blue for the ions produced by the radiation in the water. The stability of the methylene blue solutions was tested in that samples of the solutions were left standing

for one week and then examined again with the spectrophotometer. The samples which had been exposed to the light in the meantime showed slightly diminished absorption, whereas samples which had been kept in the dark showed no change after one week. Thus the methylene blue seemed both stable enough and sensitive enough to be used for measurements of roentgen dosage. This conclusion was contradicted by further experiments, which will be mentioned later. It was objectionable to use a glass container if radiations of different hardness were to be compared with one another.

In trying to find material for suitable containers we decided that kodaloid<sup>1</sup> offered several advantages. Cylindrical containers were made by rolling the material around a rod, dissolving and softening the edges with acetone, and sealing on the bottom piece in the same manner. After the containers were dry the solution was poured in and a cover sealed on. When the solution was irradiated in these containers the change was less than one-half of what it had been in the glass tubes. It seemed possible that a small amount of the acetone had been brought into the solution and that the acetone in competition with the methylene blue had utilized part of the energy supplied by the roentgen rays. A drop of acetone was, therefore, added to the solution in one glass tube and that tube irradiated at the same time as a solution free from acetone. The effect on the methylene blue in the latter solution was several times greater than on that in the former, indicating that the effect of the roentgen radiation had been utilized mainly by the acetone. The acetone did not change the color before irradiation of the solution. This experiment indicated that a very small organic impurity may change the effect on the substance which is being tested, especially

<sup>1</sup>This is a cellulose product which can be obtained in sheets from the Eastman Kodak Company. It is an organic material with about the same absorption and scattering coefficient as water and it can be obtained in very uniform thickness.

when weak solutions are used. It was also a warning that special precautions have to be taken if such solutions are going to be used for measurements of dosage. (If a number of glass tubes, which have been

The figures in the same horizontal lines refer to tubes irradiated together for the same length of time.  $\text{CaCl}_2$  does not influence the amount of change, whereas ethyl alcohol and sucrose reduce the change of

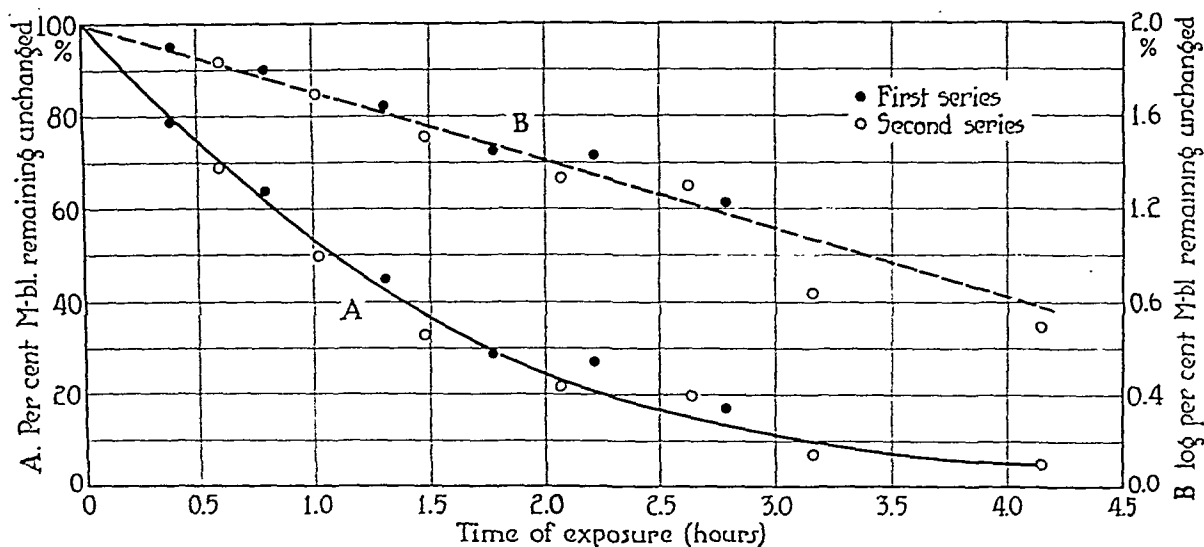


Fig. 2. (A) Decomposition of methylene blue. (B) Logarithmic curve of the decomposition of methylene blue.

cleaned together, are filled with parts of the same solution at the same time, one can, however, be reasonably sure that they can be used for comparison of dosage.) The effect of a small amount of acetone in the methylene blue solution undoubtedly explains why Clark and Pickett failed to get any decomposition of methylene blue dissolved in acetone.

The fact that very small amounts of substances influenced by roentgen irradiation reduce the change of the methylene blue makes such solutions sensitive indicators to test, whether the added substance is affected by the radiation or not. It seems that the method might be worked out for quantitative determinations.

Some preliminary experiments were carried out with ethyl alcohol, sucrose,  $\text{CaCl}_2$ , and phenol as added impurities. The results are summarized in Table II. Each glass tube contained 0.0016 mg. methylene blue and 0.02 mg. of added substance per c.c. of solution.

TABLE II.—PERCENTAGE OF METHYLENE BLUE CHANGED

With no impurity %	With addition of 0.02 mg.			
	Alcohol %	Sucrose %	$\text{CaCl}_2$ %	Phenol %
51	19	17	51	
88				30
98				41

methylene blue to about the same extent. The quantitative relations have not been studied as yet, but it has been shown that if one-tenth as much of the substance is added as impurity, the influence of it is much more than one-tenth as great. It should be mentioned that it has been discovered before that sucrose and phenol in aqueous solutions are influenced by roentgen irradiation.

Another factor which has a decided influence upon the radiation effect is the hydrogen ion concentration of the solution. Unfortunately we cannot give the exact pH value for the solutions referred to in this article (the methylene blue solutions had a pH

of about 7), but that will have to be determined in further experiments.

The investigation unfortunately had to be interrupted, but we hope to be able to continue the study later. It seems of special importance to point out that small amounts of impurities may have a decided influence on the action of roentgen rays on weak solutions, and, further, that such weak solutions of suitable compounds can be utilized for the indirect study of the effect of roentgen rays on other substances which cannot be measured accurately in such small quantities as usually are to be considered in experiments of this type.

#### SUMMARY

1. Several colored solutions have been irradiated by roentgen rays and the change of color has been measured by means of a spectrophotometer.

2. It was thought that a color change measured quantitatively might be used as a means to determine dosage. Of the substances which were affected to an appreciable extent, methylene blue seemed to be most suitable for this purpose, and was studied further.

3. A quantitative relation between the color change and the dose was obtained, but it was found that small impurities of organic substances disturbed this relationship. The hydrogen ion concentration also had a decided influence. Extreme precautions, therefore, have to be taken if such changes

are going to be used for determination of dosage. This undoubtedly is true for whatever chemical method is being used.

4. The change of color produced by roentgen rays was not affected by calcium chloride but was definitely and to about the same extent influenced by small amounts of acetone, ethyl alcohol, sucrose, and phenol. Probably the effect of the radiation is divided between the methylene blue and the impurity, and it may be possible in this way to study the effect on the substance added to the colored solution. Such small amounts are, as a rule, changed by the radiation that for many substances it would be impossible to discover the effect of it by the direct method.

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## ROENTGENOLOGIC CHANGES IN SARCOID AND RELATED LESIONS<sup>1</sup>

By B. R. KIRKLIN, M.D., Section on Roentgenology, The Mayo Clinic, and  
S. ARCHIBALD MORTON, M.D., Fellow in Radiology, The Mayo Foundation,  
ROCHESTER, MINNESOTA

THE disease known as Boeck's sarcoid is characterized primarily by the formation of nodules in the cutaneous and subcutaneous tissues. The skin over these areas has a telangiectatic appearance. The distribution of the lesions and the histologic picture are distinctive. Closely related to this lesion are the diseases known as Darier-Roussy sarcoid, lupus pernio, and erythema induratum. In this group of related diseases there are sometimes accompanying systemic complaints and more or less characteristic lesions in organs other than the skin. Among the systemic lesions that have been described are fibrocystic changes in the bones, infiltration in the lungs, adenopathy of the cervical lymph nodes, splenomegaly, tonsillar swelling, iritis, and infiltrations in the mucous membranes of the upper air passages.

Various hypotheses with regard to the etiology of this disease have been advanced: for example, that it is due to the bacillus of tuberculosis; that it is a separate disease entity, or that several factors are involved.

In certain cases the bacillus of tuberculosis has been isolated from the lesions in the skin, and definite tuberculous lesions have often been found. In other cases there is no evidence of tuberculosis and even the tuberculin test gives a negative reaction. The fact that a general lymphadenopathy sometimes occurs suggests the possibility that the condition is related to lymphoma. The favorable results reported in certain cases following roentgen-ray treatment would tend to substantiate this view. It is Voorhoeve's belief that, since the central nervous system is often involved, the lesions in the bones are

of a trophic nature. He cited, to support this view, observations at necropsy in a case originally reported by Winkler in which there were definite changes in the nervous system.

Because of the fact that Boeck's sarcoid with visceral involvement is seldom fatal, pathologic descriptions of the visceral lesions are meager. Schaumann (13, 14) studied the bones histologically in cases in which the finger or toe had been amputated and reported that the findings strongly resembled those found in bones involved in lymphomatous processes. Hence he called sarcoid with visceral involvement "benign lymphogranuloma." The patient with sarcoid of the lung described by Bernstein, Konzleemann, and Sidlick (2) came to necropsy and lesions were found in the bronchial mucous membrane resembling sarcoid as it occurs in the skin.

The questions of etiology and the relation of the various types of sarcoid to one another are for the dermatologists to settle. Goeckerman (6) has given a very complete summary of the present opinion on these questions. It is, however, important for the roentgenologist to know that in the cases diagnosed as belonging to the sarcoid group there are roentgenologic signs which are more or less characteristic of the condition. These occur as changes in the bones and in the lungs.

### CHANGES IN THE BONES

The first report of involvement of bone in cases of sarcoid lesions as noted by the roentgen ray apparently was that of Kreibich (8), who, in 1904, published a roentgenogram of the hands in a case of lupus

<sup>1</sup>Submitted for publication December 6, 1930.

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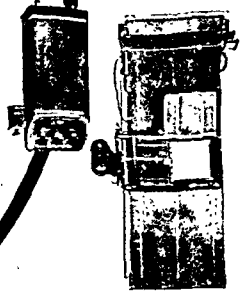
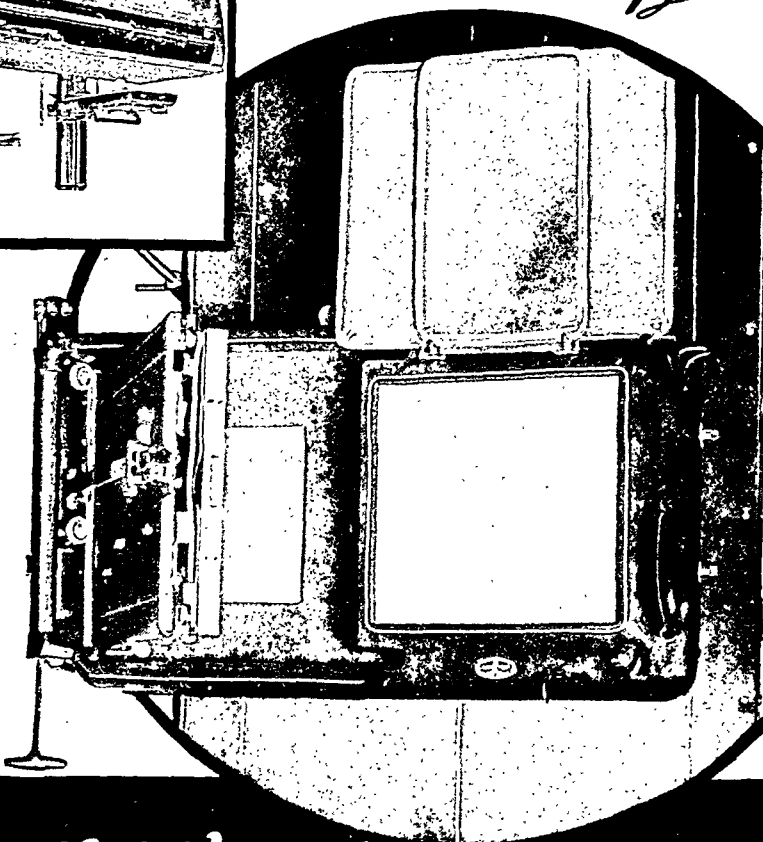
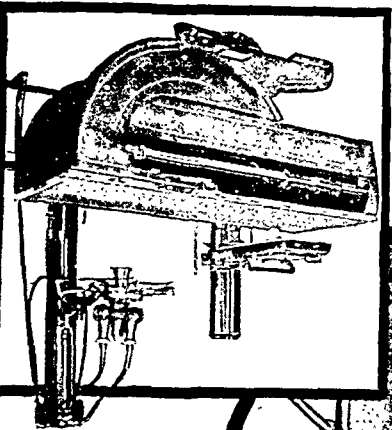
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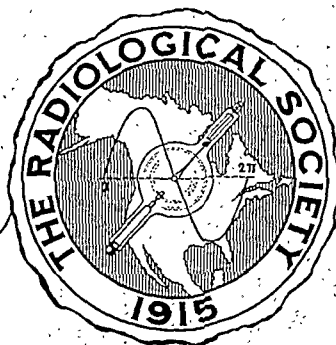
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## ROENTGEN KYMOGRAPHY AS A DIAGNOSTIC AID<sup>1</sup>

By PROFESSOR PLEIKART STUMPF, *Munich, Germany*

THE use of kinetic phenomena as diagnostic aids in medicine has long been customary. Movement is certainly one of the basic factors of life in general. Attention has always been paid in roentgenology to movements within the body. In the last few years one could observe that the interest has shifted to the exact study of morphology. This was due to the enormous development of photographic technic which made it possible to produce structural films of undreamed-of clarity and delineation in a short space of time. In daily practice only the fluoroscope was at hand for the study of movement. Its disadvantages are well known. Aside from bad visibility, the subjective nature of the observation which allows the greatest freedom of deductions is not advantageous.

It was my intention to give to the studies of movement the advantages of photographic fixity. I did this in the hope that it would lead to an increase in our knowledge, just as photography accelerated our studies of morphology. For this purpose I have developed the method of kymography, which has been applied in medicine as a procedure for the recording of moving parts, as in pulse records, and kinetics in general.

The recording of movement by kymography depends in principle upon the equivalent

change of the recording point during the filming. This is due to the fact that the single time films do not overlap. As an expression of the movements a curve is formed which shows no gaps in time. The earlier attempts at roentgen kymography limited themselves to a recording of the movement of individual points on an organ. Such a procedure would be useful if the movements of all points on an organ were equivalent as they are in solid inanimate bodies. But this is not the case. The changes in form during movement are always manifold since we are dealing with elastic masses. Therefore, the recording of movement must be extended to a whole plane. Only in this way is it possible to follow the changes in movement as well as in form of an organ.

These kymograms have the particular advantage that they fix all the movements in a curve, subject to objective interpretation, and that furthermore, there exists the possibility of visualization of the movements again as a sensory impression.

For diagnosis we use both types of interpretation. For the small and rapid movements of the heart the curve serves better; for the complicated gastric movements the general picture of the process is usually more important.

Movements in the interior of the body have varying causes. We distinguish between primary and secondary movements. The division of those two forms is unthinkable

<sup>1</sup> Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13-17, 1937.

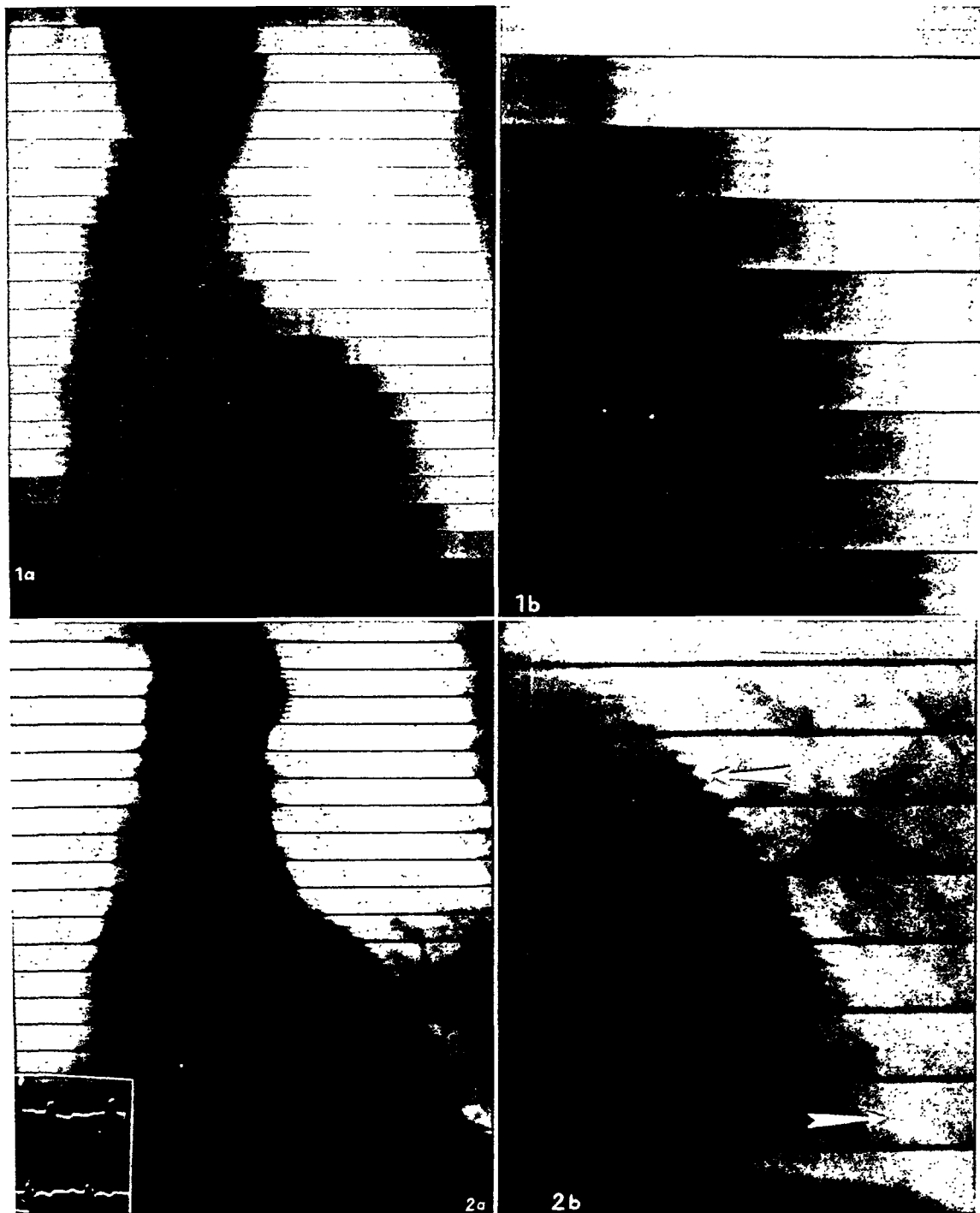


Fig. 1-a (upper left). In the case of alterations of the myocardium (infarct), the curves show changes at a distinctly limited area.

Fig. 1-b (upper right). Section of the kymogram from the left ventricle.

Fig. 2-a (lower left). When the muscles refuse completely to act, the wall is turned out during the systole. This may be recognized by the displacement of the curves.

Fig. 2-b (lower right). Section of the kymogram from the left ventricle. Arrows show contrary movements in the ventricular region.

able by purely technical means. This is possible only through a thoughtful inter-

pretation of the fixed images. This applies to normal and pathologic movements.

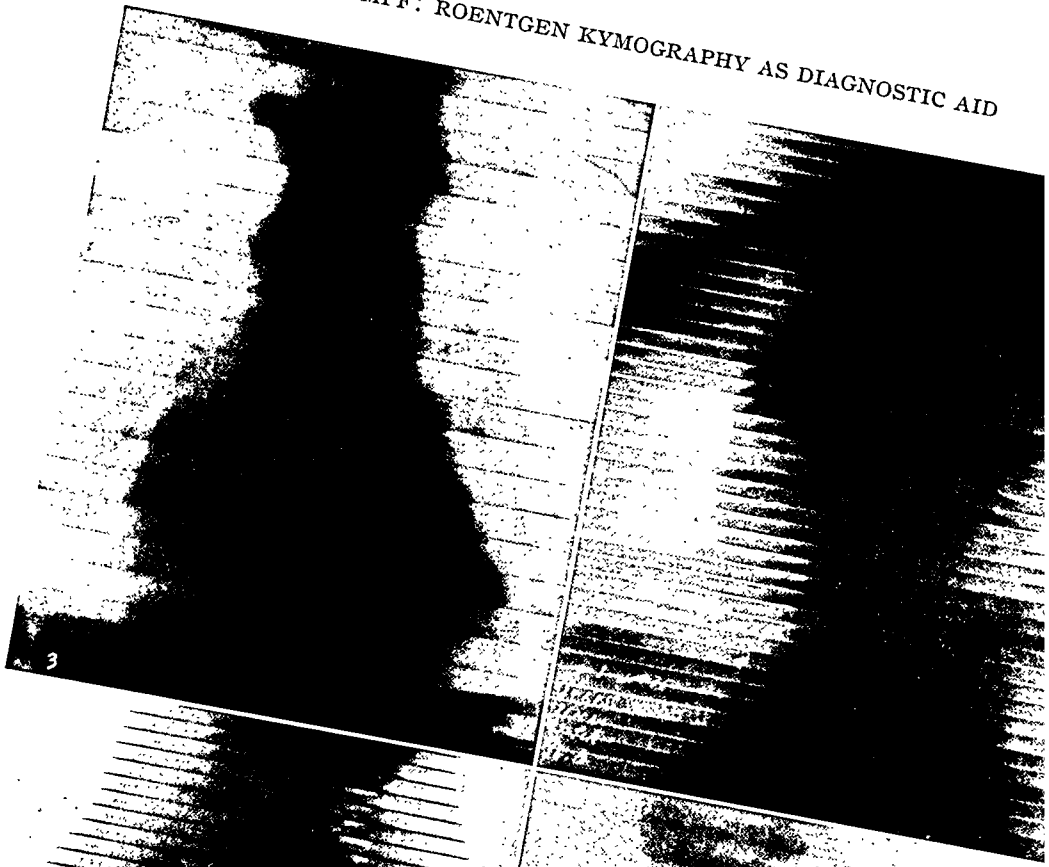


Fig. 3 (*upper left*). In the case of pericardial alterations (concretio-pericardii), we note a stoppage of marginal movements.  
 Fig. 4 (*upper right*). Kymogram of the swallowing movement in a case of freely movable goiter.  
 Fig. 5 (*lower left*). In case of mediastinal adhesions, there is no movement.  
 Fig. 6 (*lower right*). Kymogram of a normal stomach (exposure 60 sec., 6 ma., 80 kv.).

This division is not a technical but a purely medical problem. As in morphology in which there are many variants of the normal development of organs, so is the number of varieties of movements even larger.

The recognition of pathologic movements demands great experience and much thought. The development of kymography has been rapid, but not at all completed as yet, since further close study also

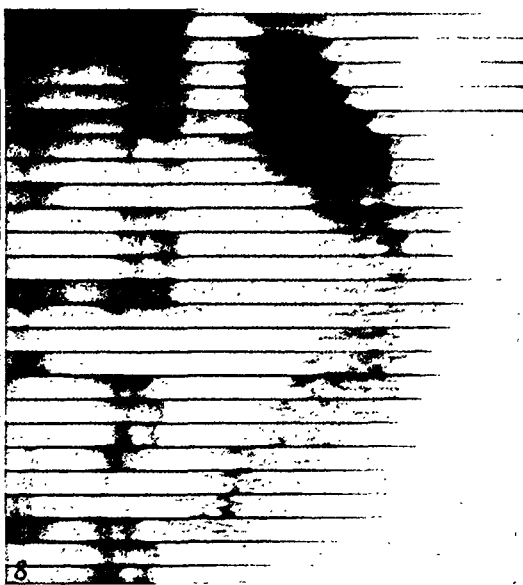


Fig. 7. Film shows the movement of gastric mucosal relief, taken with patient lying down. Very little opaque meal used. The folds are becoming broad and narrow according to the movement of the exterior wall.

Fig. 8. Movement of the folds in a case of gastritis. Folds show little and disordered movements.

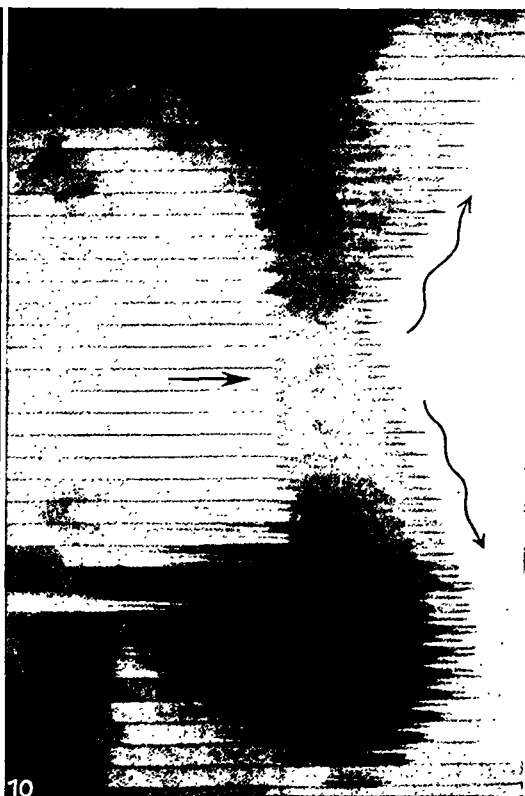


Fig. 9. Ulcer of the stomach showing a niche. The niche shows only a passive movement. We also note other motor disturbances (partial retroperistalsis).

Fig. 10. Ulcer of the posterior wall showing partial retroperistalsis in the segment of the ulcer. Arrow shows the ulcer.

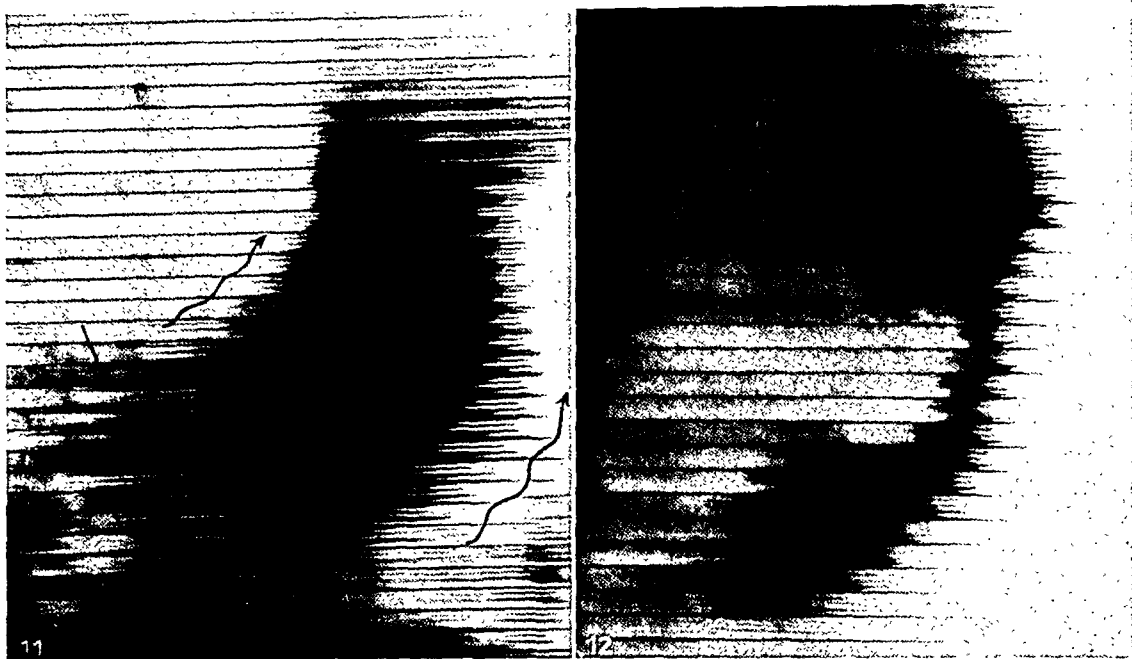


Fig. 11. In a case of pyloric ulcer we diagnose a perfect retroperistalsis but no delay in emptying.  
 Fig. 12. In case of cancer the rigidity shows the extension of malignant infiltration.



Fig. 13. Dissection showing the ulcer (arrow).

increases the knowledge of normal variations. Kymography has for its aim the making of more objective fluoroscopic observations, thus to bring into view processes of movements not recognizable by other means.

I shall attempt to show you by means of

films how the kymogram has solved these problems.

The "planar kymograms" are obtained by the interposition of a moving drum which is moved in equal distances during the exposure. One obtains numerous curves which cover the surface of the film.



Fig. 14 (*upper left*). In case of carcinoma involving the pylorus we often diagnose retroperistalsis.

Fig. 15 (*upper right*). Small malignant infiltrations show a limited lack of movements. This portion is only passively moved by peristalsis. Arrow shows the position of the small carcinoma.

Fig. 16 (*lower left*). Kymogram of the moving small intestine.

Fig. 17 (*lower right*). Kymogram of the moving large intestine; exposure of three minutes.

In a kymogram of a knee joint during movement, one obtains a flat kymogram, the curves of which are an expression of the movement. If one moves the drum across the field of vision, one interval of time becomes visible. If one-half of the kymogram is covered, when one moves the drum

the pictures arrange themselves, and one perceives in the covered portion the impression of movement. In a flat kymogram of respiration, through the movement of the drum one receives the picture of breathing. Each process is reproduced many times in one demonstration. In the flat kymogram



of the movement of the heart, the pointer shows the curves. For the diagnostic evaluation of the cardiac kymogram it is more advantageous to consider the curves around the edge. In myocardial damage (infarct), the appearance of the curves changes at the given place (Fig. 1-a). The pointer shows the site of infarction.

When the film is moved the changes in movement are more difficult to recognize than by means of the curves. It is possible to draw the median movement (systole) by means of compasses, which delineate a systole in the cranial portions of the heart chambers and at the same time a lateral movement in the caudal portions. With pericardial changes (concretio-pericardii), the movements of the cardiac borders cease (Fig. 3). A kymogram showing the act of swallowing with a freely moving struma is reproduced in Figure 4. This movement ceases in the presence of mediastinal growths (Fig. 5).

In a flat kymogram (Fig. 6) of a stomach (exposure 60 sec. with 6 ma. and 80 kv.), the demonstration is ten times as fast as the natural process.

Figure 7 shows a film of the movements of the mucosal folds. The folds follow the movements of the borders and show movements away from and toward each other. Figure 8 shows the movements of the folds in gastritis. The folds do not move rhythmically nor in an orderly fashion.

In gastric ulcer (Fig. 9) the niche is passive and there are general disturbances of movement (partial retroperistalsis). In ulcer of the posterior wall (Fig. 10) one sees partial retroperistalsis in the segment of the ulcer. The pointer shows the area of the ulcer. In ulcer of the pylorus (Fig. 11) there is complete retroperistalsis with good emptying of the stomach. In carcinoma (Fig. 12), immobility is a sign of a spread of the infiltration. In carcinoma of the

pylorus (Fig. 14) one often sees retroperistalsis. Small carcinomas show a circumscribed immobility which is included in the peristaltic movements (Fig. 15). The movement of the small intestine is often pendular (Fig. 16), and is increased when stimulated. Figure 16 is a reproduction of a flat kymogram of the movements of the small intestine (exposure 15 sec., five times normal speed). The movements of the large intestine are slow; they are not visible in the fluoroscope. The flat kymogram shown in Figure 17 was taken in three minutes with a low current.

### CONCLUSIONS

I hope that I have convinced you that the kymogram is a useful aid to diagnosis; that it brings into objective view all movements and that the interpretation of the curves in the stationary film and the observations made in the moving film lead to the grasp of phenomena which escape the usual procedures employed in diagnosis.

The use of the kymographic method in practice is quite simple, since the necessary apparatus has no complicated parts and is based on the principle of moving the film by means of a drum.

The use of materials is small, since all movements may be recorded on one film of ordinary size. It is evident that the study of morphology should never be neglected. Therefore, I have built the apparatus in such a manner that ordinary exposures with and without filters, focused exposures and serial films can be taken without changing anything in the apparatus. The kymograms, therefore, fit in with the usual working methods and do not take any considerable time. They represent an added step toward better diagnosis. Morphology and movement belong together, just as they are indivisible in life.

# THE ROENTGENOLOGIC DIAGNOSIS OF TUMORS INVOLVING THE SACRUM<sup>1</sup>

By JOHN D. CAMP, M.D., Section on Roentgenology, The Mayo Clinic, and  
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THE sacrum may be involved by a wide variety of tumors, both benign and malignant. This involvement is often sufficient to produce changes demonstrable in the roentgenogram which at times are characteristic of a particular type of tumor.

Other than instances of metastatic involvement of the sacrum we have observed 41 cases in which involvement of the sacrum by a tumor was demonstrable roentgenologically. In 28, or 68 per cent, of these cases tissue obtained from the tumor was examined by a pathologist.

within the sacral canal, (2) tumors arising from the body of the sacrum, and (3) tumors arising from structures adjacent to the sacrum.

In general, it may be stated that malignant tumors infiltrate and destroy the sacrum, rendering a diagnosis of malignant disease possible from the roentgenogram alone. Benign tumors, on the other hand, deform the bone but do not invade it. The sacrum may be eroded by pressure from a contiguous benign tumor, but there will be no invasion with subsequent destruction. From the characteristics of the

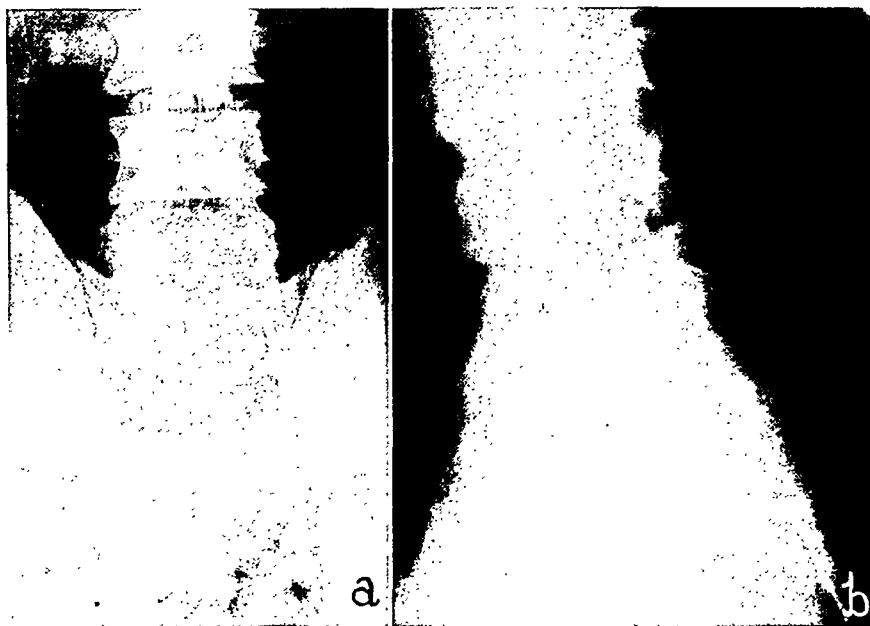


Fig. 1-A. Ependymal-cell glioma involving the sacrum and last three lumbar vertebrae; the margins of the sacral defect are sharp and well-defined.

Fig. 1-B. Lateral roentgenogram showing the typical expansion of the sacral canal by an ependymal-cell glioma.

The tumors involving the sacrum may be grouped as benign and malignant and may be classified further according to point of origin, as follows: (1) tumors arising

erosion it is often possible to place the tumor in one of the classifications that have been listed. For example, tumors arising within the sacral canal cause erosion which increases the diameter of the canal, as will be discussed later.

<sup>1</sup> Submitted for publication Aug. 23, 1938.

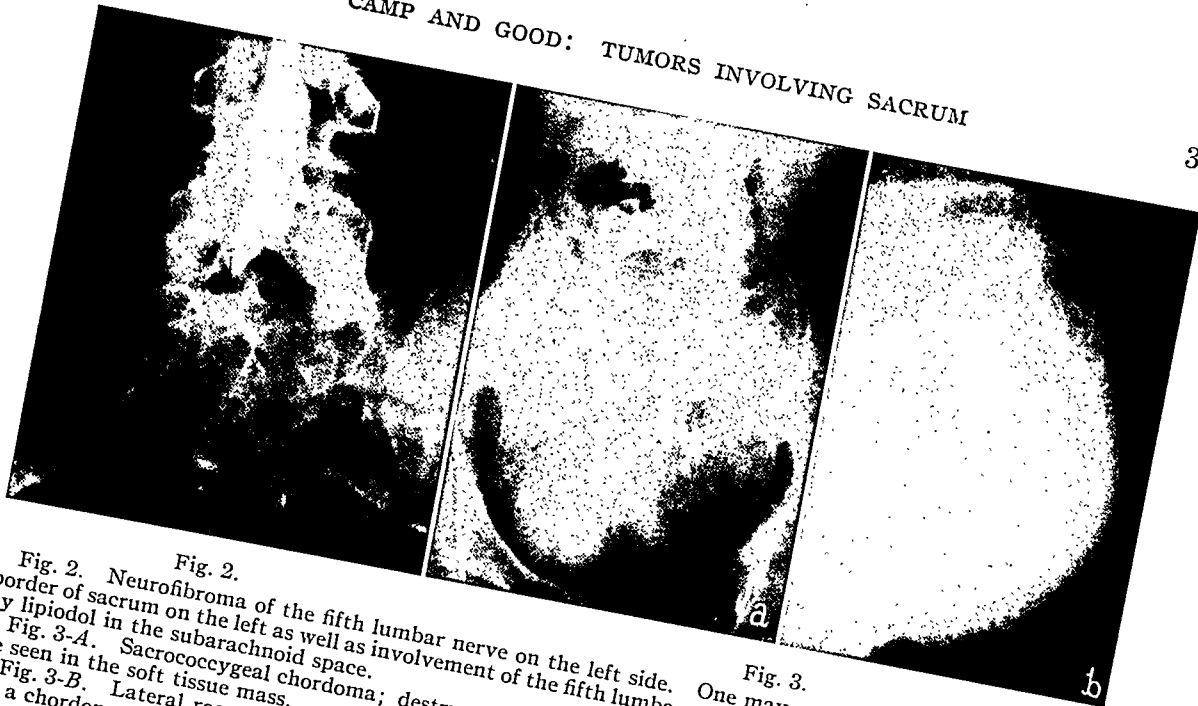


Fig. 2.

Fig. 2. Neurofibroma of the fifth lumbar nerve on the left side. One may note the erosion of the upper border of sacrum on the left as well as involvement of the fifth lumbar vertebra; the tumor is delineated above by lipiodol in the subarachnoid space.

Fig. 3-A. Sacrococcygeal chordoma; destruction of the sacrum is pronounced and remnants of bone may be seen in the soft tissue mass.

Fig. 3-B. Lateral roentgenogram showing the expansion of the sacrum in the anteroposterior diameter by a chordoma.

Fig. 3.

#### TUMORS ARISING WITHIN THE SACRAL CANAL

In 14 of the 41 cases observed the tumors arose within the sacral canal. Tissue obtained from 11 of these tumors was examined by the pathologist. In the remaining three cases the diagnosis was made on the basis of clinical and roentgenologic findings. Twelve tumors were ependymal-cell gliomas and two were neurofibromas.

of the lumbar vertebræ, as well as the sacrum, may be involved. When this is the case, the cartilaginous intervertebral disks, which are resistant to pressure, remain intact. Because of the lobulated

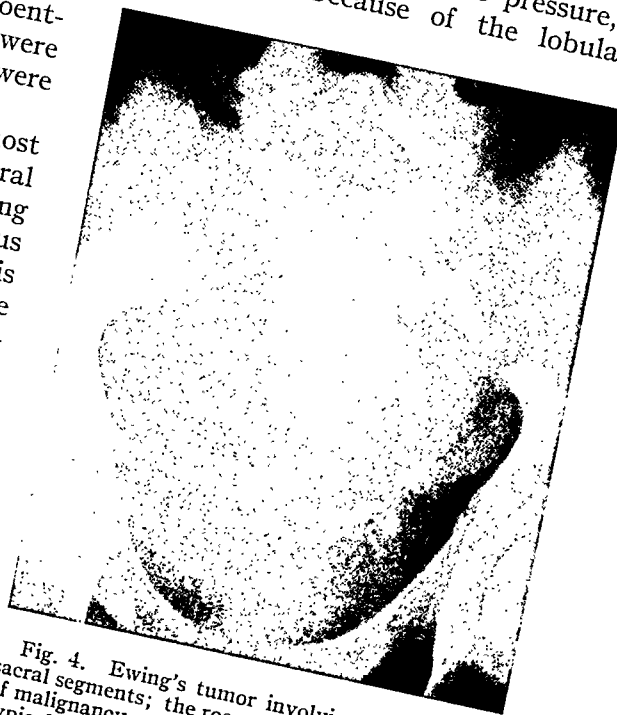


Fig. 4. Ewing's tumor involving the first two sacral segments; the roentgenologic characteristics of malignancy are well shown, but there is nothing typical of Ewing's tumor.

The ependymal-cell glioma is the most common tumor arising within the sacral canal. It is derived from the cells lining the central canal of the spinal cord, conus and filum terminale (1). Whereas this tumor is classified as malignant by the pathologist, roentgenologically it resembles a benign tumor. This is probably due to the fact that the tumor is intradural and the dura therefore offers an obstacle to invasion of the surrounding bone and tends to keep the tumor encapsulated. These tumors cause erosion of the sacral canal by expansion and direct pressure; the margins of the eroded bone are sharp and well defined (Fig. 1). The growth may originate at any point in the spinal canal and often attains considerable size. Thus several



Fig. 5.

Fig. 5. Benign giant-cell tumor involving the sacrum; appearance before roentgen therapy.



Fig. 6.

Fig. 6. Benign giant-cell tumor involving the sacrum (same tumor as shown in Figure 5); appearance following roentgen therapy. One may note regeneration of bone.

character of the tumor the sacrum is often eroded in an irregular manner, which causes a multiloculated appearance.

Roentgenologically, ependymal-cell gliomas must be distinguished from benign giant-cell tumors of the sacrum and from spina bifida occulta. In the former the multilocular cysts are part of the bone itself, whereas the ependymal-cell glioma produces pseudocysts by expansion and erosion of the bony surroundings of the sacral canal. Spina bifida occulta may be confounded with erosion of the laminae and spinous processes although in the former decalcification that is due to pressure erosion is absent unless a meningocele is co-existent.

Changes similar to those produced by ependymal-cell gliomas are caused by neurofibromas. These tumors arise from the roots of the spinal nerves and may be intradural or extradural. They frequently extend along the course of a nerve and produce a dumbbell-shaped mass which extends both intradurally and extradurally. The erosion of the sacral canal that is produced by a neurofibroma is identical to

that observed in the case of the ependymal-cell glioma, but, in addition, erosion of the sacral foramina and even of the external surface of the sacrum may occur (Fig. 2). The margins of the eroded bone also are sharp and well defined.

#### TUMORS ARISING FROM THE SACRUM

Twenty of the 41 tumors in this series arose from the sacrum. Eleven of these tumors were examined by the pathologist, while the remaining nine were classified according to clinical and roentgenologic findings. These 20 tumors were classified as follows: ten were chordomas; three were sarcomas; one was a benign giant-cell tumor; one was a Ewing tumor, and five were classified as malignant tumors.

In this series of cases the most common tumor arising from the sacrum was the chordoma. This tumor has its origin from remnants of the notocord (2). Roentgenologically, the most characteristic feature of the chordoma is the fact that it usually causes expansion of the sacrum, especially in the anteroposterior diameter (Figs. 3-A, 3-B), although infiltrative destruction of

the bone is pronounced and furnishes an immediate clue to the malignant nature of the tumor. In some cases remnants of bone are seen to be free in the large soft mass of the tumor. These may be increased in density and may simulate sequestra and even calcification.

In all of the cases of chordoma reviewed it was possible to make a diagnosis of malignant disease of the sacrum. In a few, however, the changes that were apparent in the roentgenograms were insufficiently characteristic to permit a more specific diagnosis.

Hsieh and Hsieh (3) recently reported a study of three cases of sacrococcygeal chordoma. They enumerated the following roentgenologic signs: (1) expansion of the sacrum, (2) destruction, (3) trabeculation, and (4) calcification. In general, their findings agreed with ours.

The roentgenologic appearance of Ewing's tumor of the sacrum is not as characteristic as that of Ewing's tumor of the long bones. The predominant feature is destruction, as is the case of all malignant lesions of the sacrum (Fig. 4). It rarely is possible for the roentgenologist to make a more specific diagnosis than malignant disease from the roentgenologic findings alone. This is also true in most cases of osteogenic sarcoma.

In five of the 20 cases in this group the clinical, surgical, and roentgenologic findings were insufficient to permit a more specific diagnosis than that of malignant disease involving the sacrum.

Benign giant-cell tumor involving the sacrum usually shows the characteristics which it exhibits elsewhere in the skeleton. Trabeculation takes place, together with formation of multiloculated cysts and deformity of the sacral outline (Fig. 5). Regeneration and recalcification of bone occur following roentgen therapy (Fig. 6).

#### TUMORS ARISING FROM STRUCTURES ADJACENT TO THE SACRUM

In seven of the 41 cases reviewed the tumors arose from structures adjacent to the sacrum and involving it because of its



Fig. 7 (above). Teratoma arising in front of the sacrum, which has been deformed by the pressure of the tumor; the visible masses of calcification are caused by teeth in the tumor.

Fig. 8 (below). Metastatic carcinoma involving the sacrum; the primary site was in the prostate gland.

proximity. In six of these cases the tumors were examined by the pathologist, while in one case the diagnosis was made by

a combination of clinical and roentgenologic data. In four of the seven cases the tumors were called teratomas, while in the other three cases there were malignant tumors that had involved the sacrum secondarily.

In the three cases in which a malignant tumor had involved the sacrum secondarily the roentgenologic findings were similar in every respect to those encoun-

teratoma must be distinguished from meningocele and spina bifida. In a case of teratoma there is decalcification of the eroded surfaces, while the separation of the laminae is clearly defined in cases of spina bifida or meningocele.

The lesions that most frequently simulate tumors involving the sacrum are metastatic carcinoma (Fig. 8), multiple myeloma, and osteomyelitis. The first

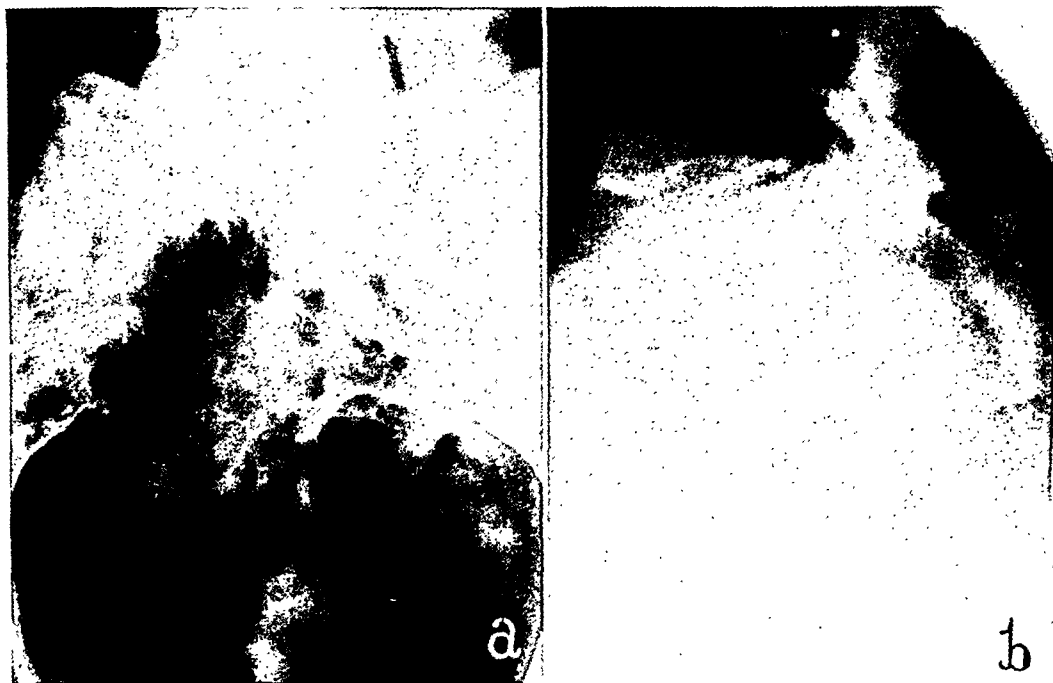


Fig. 9-A. Atypical involvement of sacrum by multiple myeloma.  
Fig. 9-B. Lateral roentgenogram of sacrum.

tered in other cases of malignant involvement of the sacrum, whether the involvement was primary or secondary. It is impossible for the roentgenologist to predict the origin of the tumor in more than a very few instances; the only permissible diagnosis is malignant disease of the sacrum.

The teratomas were remarkable because of the extensive deformity of the sacrum which often was associated with these tumors. Erosion of the anterior or posterior surface of the sacrum may be present as a result of pressure. Occasionally, calcification or the formation of a tooth is noted in the soft tissue mass (Fig. 7).

may be distinguished by identification of a primary tumor, or by the presence of involvement of other portions of the skeleton. Multiple myeloma is a disease of more than a single bone, and usually may be distinguished by involvement elsewhere in the skeleton, especially of the ribs, skull, and vertebrae. In one case in this series, however, the sacrum was involved by an infiltrating malignant tumor which caused some expansion of the bone, especially in the anteroposterior diameter (Figs. 9-A and 9-B). No other skeletal involvement was noted. A diagnosis of myeloma was made by the clinician because of the presence of Bence-Jones protein in the urine.

Examination two years later disclosed involvement of ribs and vertebræ which was typical of multiple myeloma.

Osteomyelitis, because of its inflammatory nature, generally causes a certain amount of reaction in the surrounding bone. It usually begins in or near the sacro-iliac joint and may often be distinguished clinically.

#### SUMMARY

Exclusive of metastatic processes, tumors involving the sacrum may be classified according to point of origin as follows: (1) tumors arising within the sacral canal; (2) tumors arising from the body of the sacrum, and (3) tumors arising from structures adjacent to the sacrum. The most common tumor arising within the sacral canal is the ependymal-cell glioma. This tumor causes erosion of the sacral canal by expansion and direct pressure. The margins of the eroded bone are sharp and well-defined. Similar changes, which often are associated with erosion of a sacral fora-

men, are caused by neurofibromas. The most common tumor arising from the body of the sacrum is the chordoma. The most characteristic feature of the changes produced by a chordoma is the expansion of the sacrum by an infiltrative destructive process. It is often impossible to make a more specific diagnosis than "malignant tumor involving the sacrum" in cases of sarcoma, Ewing's tumor, metastatic carcinoma, and multiple myeloma. Teratomas are usually characterized by deformity or erosion of the sacrum by an extrinsic mass, in which may be seen teeth or calcification.

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# LEAD RADON TUBULES IN THE TREATMENT OF CARCINOMA OF THE TONGUE<sup>1</sup>

By FRANK E. SIMPSON, M.D., *Chicago*

IN previous articles (1) we have described lead radon tubules together with the dosage and technic which we use in carcinoma of the tongue. In the present paper we shall review our methods and discuss the results obtained in a group of unselected consecutive cases.

In the treatment of malignancy we believe one should not be prejudiced in favor of radium or surgery, but should give patients the benefit of both methods solely with the idea of obtaining the best and most permanent results. In most clinics where expert surgery and all the resources of radium are equally available, radium has largely superseded surgery in carcinoma of the anterior two-thirds of the tongue. When the lesion is very small and situated near the tip of the tongue, excision may be preferred by some. With lesions of the posterior third of the tongue, excision has been practically abandoned by all in favor of radium.

If lesions are subjected to excision, we believe it would be greatly to the patient's advantage if preliminary surface radium treatment to reduce infection and shrink the neoplasm were given by the method about to be outlined. We are opposed to attempted excision of the primary lesion with the idea of following it by radium treatment. The previous removal of a portion of the substance of the tongue takes away muscular and connective tissue necessary for the normal radium reaction. Few appear to realize the harm that may be done by incompletely excising the primary lesion and then trying to cure it with radium when the tumor bed has been irreparably damaged.

*General Care of the Patient.*—A general examination, including roentgenograms of the chest and jaws, is desirable. Success

TABLE I.—SQUAMOUS-CELL CARCINOMA OF TONGUE

No. patients.....	39	
Age		
Average.....	57 years	
Oldest.....	80 years	
Youngest.....	30 years	
Sex		Per-
Males.....	31	centage
Females.....	8	79.5
Syphilis: Definite history and Wassermann positive.....	3	20.5
Temporary resolution of tongue lesion with recurrence in tongue and neck.....	2	
Tongue lesion was not eradicated....	1	

TABLE II.—SITE OF LESION

	No.	Per-
		centage
Anterior two-thirds of tongue.....	21	53.8
Posterior third of tongue.....	10	25.6
Major part of tongue.....	8	20.5
Size of lesion		Centimeters
Diameter of largest lesion.....	7	
Diameter of smallest lesion.....	2	
Average diameter of all lesions.....	3.7	
Average diameter of cured lesions.....	3.6	
Average diameter of lesions not cured..	4.2	

in radium therapy of carcinoma of the tongue depends largely on careful attention to a chain of details. Examination of the oral cavity should be thorough but non-traumatic. We believe it is best not to disturb the tongue by any sort of manipulations within the mouth, such as the extraction of teeth, except in emergencies. Physiologic rest of the tongue is desirable. Talking should be limited and all traumatisms, such as pulling on the tongue, squeezing, rubbing, or cauterizing the lesion, should be avoided.

We advise against irrigations for purposes of disinfection, believing that the surface radium applications about to be described are immeasurably more efficient.

*Indications for Radium "Puncture."*—In the treatment of the primary lesion, surface applications of radium, although invaluable as an adjunct, have been generally

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.



TABLE III.—PATHOLOGIC TYPE OF LESION  
(BRODERS' CLASSIFICATION)

	No.	Per-centage
Grade 1.....	4	10.2
Grade 2.....	14	35.9
Grade 3.....	9	23.0
Grade 4.....	1	2.6
Cases not graded.....	11	28.2
Total.....	39	
Clinical Cures		
Grade 1.....	3	
Grade 2.....	3 <sup>1</sup>	
Grade 3.....	4	
Grade 4.....	1	
Cases not graded.....	4 <sup>2</sup>	
Total.....	15	38.5
Clinical Failures		
Grade 1.....	1	
Grade 2.....	11 <sup>3</sup>	
Grade 3.....	5	
Grade 4.....	0	
Cases not graded.....	7	
Total.....	24	61.5

<sup>1</sup> Patient, aged 40, died of double pneumonia four and one-half years after treatment; clinically free of carcinoma.

<sup>2</sup> Patient, aged 83, died of pneumonia three years after treatment; clinically free of carcinoma.

<sup>3</sup> Patient, aged 71, living two years after treatment; has metastasis in neck.

TABLE IV.—LYMPH NODES OF NECK PAL-  
PABLE AT BEGINNING OF TREATMENT

	No.	Per-centage
Cervical nodes.....	26	
Cervical and submaxillary nodes.....	3	
Cervical and submental nodes.....	3	
More than one group of nodes.....	6	
Total cases with nodes.....	26	66.6
Total cases without nodes.....	13	33.3

TABLE V.—RESULTS OF TREATMENT OF 26  
CASES WITH NODES

	No.	Per-centage
Dead.....	20	76.9
In poor condition.....	1	3.8
Clinically well.....	5	19.2

found inadequate to accomplish a clinical cure. It is usually necessary, therefore, to resort to radium "puncture." Formerly we believed the primary lesion should not be subjected to "puncture" in the presence of evident metastases. We now believe that conservative radon "puncture" may be used for palliation even though metastases are present.

For the best results the operator should be equipped with a sufficient amount of radium and a laboratory for the preparation of radon tubules. Success or failure depends on the nature and stage of development of the tumor; on the type of radium therapy used; to some extent on other factors, such as the presence of syphilis or diabetes, which influence the prognosis unfavorably.

*Methods of Implantation (Radium "Puncture").*—Two types of needles or tubules containing radium or radon have been used—the removable and the permanent. We do not favor removable needles or "seeds" because of their large size, the traumatism from the attached threads which may be sewed into the tongue, the possibilities of increased infection, and various other reasons. We have also abandoned the use of both glass and gold tubules which may be permanently implanted in the tongue. Glass tubules are efficient but cause unnecessary pain and reaction. Gold tubules, left permanently in the tongue, may cause residual pain, lasting almost indefinitely, due to the intolerance of the tissues to gold.

*Lead Tubules.*—In 1930 we began to use, for puncturing certain carcinomatous lesions, radon tubules made of capillary lead tubing. We chose lead as a jacket for radon because, from surgical experience with ordinary "lead bullets," we believed lead tubules would be well tolerated even if they remained permanently in the tissues. Later we incorporated antimony in the lead tubing in the proportion of 5 per cent in order to harden it. For convenience, we refer to these tubules as "lead" instead of "lead-antimony."

*Preparation of Lead Radon Tubules.*—The proper preparation of lead tubules in the laboratory is the foundation of success. We estimate the number of tubules that will probably be required and then make at least one-half more than the estimated number. Nothing is more disastrous than to run short of tubules after the operation has been started. The tubules are made by sealing the desired length of capillary

lead tubing to the terminal glass capillary of the radon machine; filling the tubing with a sufficient amount of radon gas, and cutting off the whole lead tubing with a special forceps. The lead tubing contain-

portant that the radon tubules, collectively and individually, be tested with the electro-scope several times in the 48 hours preceding implantation, on account of the rapid decay of leaking tubules. The length of the

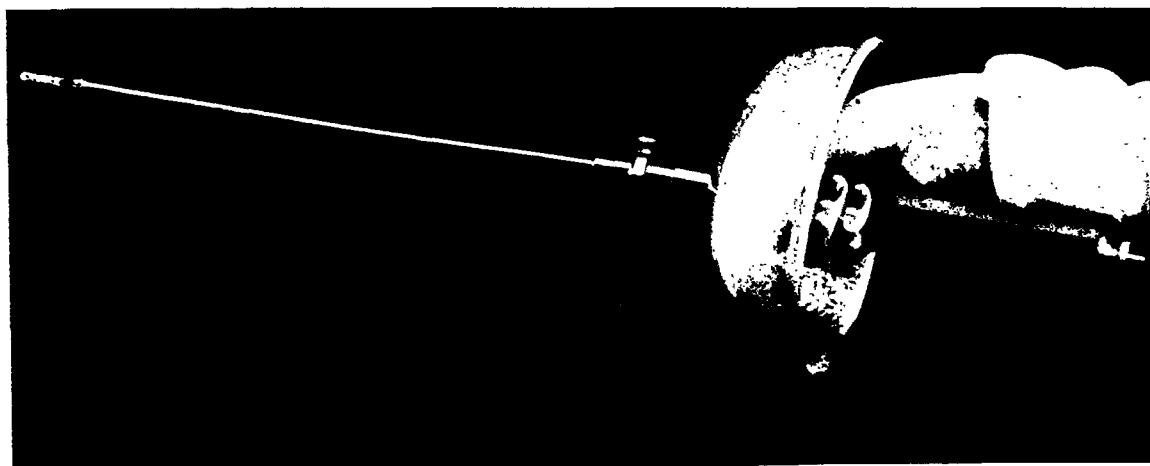


Fig. 1. Bell-shaped guard for protection of operator's hand during surface irradiation. To the distal end, the radon screen, containing from 500 to 1,000 mc. of radon, may be attached.

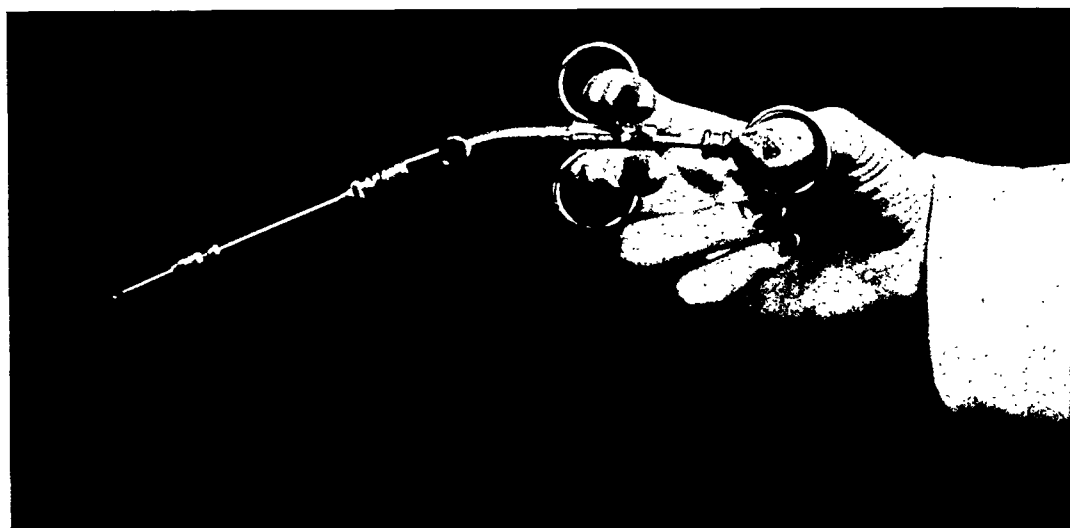


Fig. 2. Instrument for implanting lead radon tubules.

ing the radon gas is then cut into the proper number of tubules with the special forceps, which seals the ends of each tubule at the same time. In effect, a cold weld of the metal is formed. We usually make the tubules slightly stronger than desired and allow them to decay until each tubule contains approximately 0.5 mc. It is very im-

tubules is from 2 to 3 mm.; wall thickness, 0.3 mm.; internal diameter, 0.15 mm.; radon content, 0.5 mc. each. In actual practice the radon content varies slightly. These tubules transmit the gamma rays and approximately 2 per cent of the primary beta rays.

Beta rays have been estimated to be

eight to ten times as lethal to the cancer cell as gamma rays. We believe that a certain amount of beta rays and a moderately sharp reaction are not undesirable in carcinoma of the tongue.

*Technic of Surface Treatment.*—We begin the treatment of the tongue lesion by applying daily or twice daily, for approximately five minutes, from 500 to 1,000 mc. in close contact with the lesion. The radon is screened with 2 mm. of silver and sufficient rubber so that the glass radon tubes are exactly 6 mm. distant from the lesion. Great care must be used not to rub or manipulate the lesion.

For protection of the body from the gamma rays, the operator stands or sits behind a heavy lead angle plate. For the protection of the operator's hand, we have devised a bell-shaped guard (Fig. 1) similar to a fencing foil guard. To the distal end of the bell-shaped guard, which is covered with one-fourth of an inch of lead, is attached a flexible copper wire 12 inches long and one-eighth of an inch in diameter. The screen containing from 500 to 1,000 mc. of radon is attached to the distal end of the copper wire.

Approximately from 250 to 300 mc.-hr. may be given to a single area. Dosage varies, however, with the amount of elevation of the carcinoma above the level of the tongue, so that it is difficult to lay down definite rules.

The importance of these preliminary surface irradiations in reducing infection and delimiting and shrinking the neoplasm can hardly be overestimated. We have also entertained the hope that carcinoma cells lying near the surface may be devitalized, thus making radium "puncture" safer from the standpoint of metastasis.

*Biopsy.*—A few days after surface irradiations have been begun, we carefully biopsy the lesion with a sharp knife. We do not apply caustics to the biopsied area because of the well-known stimulating effect of caustics on carcinoma. It seems logical to believe also that a little free bleeding after biopsy may wash out loose carcinoma cells.

TABLE VI.—RESULTS OF TREATMENT OF 13 CASES WITHOUT NODES

	No.	Per-centage
Dead.....	5	38.4
Clinically well.....	8	61.5

TABLE VII.—RESULTS TO MAY 1, 1937, IN 39 CASES: 26 CASES WITH AND 13 CASES WITHOUT NODES

	No.	Per-centage
Dead of carcinoma.....	23	58.97
In poor condition.....	1	2.56
Clinically well of carcinoma, one over four years and one over three years, but died later of intercurrent disease	2	5.12
Clinically well.....	13	33.33

TABLE VIII.—DURATION OF LIFE AFTER TREATMENT IN 25 CASES THAT DIED

	No.
Lived over 5 years.....	0
Lived over 4 years.....	1
Lived over 3 years.....	1
Lived over 2 years.....	3
Lived over 1 year.....	7
Lived less than 1 year.....	13
Total.....	25

*Technic of Radon "Puncture."*—Having prepared the "soil" by preliminary surface irradiations, the lead radon "seeds" may be implanted. The utmost gentleness should be used in dealing with the carcinomatous tongue. Pulling on the tongue, squeezing, or rough sponging of the lesion should be avoided. We prefer to block the lingual nerve rather than to use general anesthesia.

For the implantation of tubules we have devised a small instrument (tubule introducer), a description (2) of which was published in 1922 (Fig. 2). This instrument is constructed on the plan of an ordinary syringe. Needles of different lengths and curves may be attached to the distal end of the instrument. The lead tubules are inserted into the distal end of the needle and dislodged by an obturator which slides in the lumen of the needle. Ordinarily two tubules may be implanted at each puncture. While regard must be paid to the peculiarities of the individual lesion, our

general plan is to implant the tubules in the shape of a truncated cone, the smaller end of the cone lying toward the surface.

of the tongue and pushed gently inward to the desired spot. The needle may then be withdrawn a few millimeters and the



Fig. 3.

Fig. 3. Carcinoma of the tongue before treatment.



Fig. 4.

Fig. 4. Same patient after radium treatment. Living and clinically well over three years.

“Stabbing” the lesion with the needle of the introducer is to be avoided. The point of the needle containing the radon seeds should be placed carefully on the surface

tubules gently deposited by means of the obturator in the minute cavity created.

For lesions far back in the tongue, we use curved needles by means of which the affected area can be implanted from the mucous membrane surface, with the aid of a laryngeal mirror. For posterior lesions, we have not used the method suggested by different authors of nicking the skin in the submental region and pushing implantation needles into the incision until they engage in the carcinoma, because we fear that while withdrawing the needles along a tract of healthy tissue, transplantation of cancer cells may occur. We regard it as very important to use a fresh sterile needle and obturator for each puncture in order to obviate the possibility of transplanting cancer cells or introducing additional infection.

We have found it convenient to slip a small sliding guard, or metal node, over each needle used for implantation. This contrivance, known as a “cravat pin guard,” may be obtained in any haberdashery. By means of this guard, the distance from the end of the needle in centi-

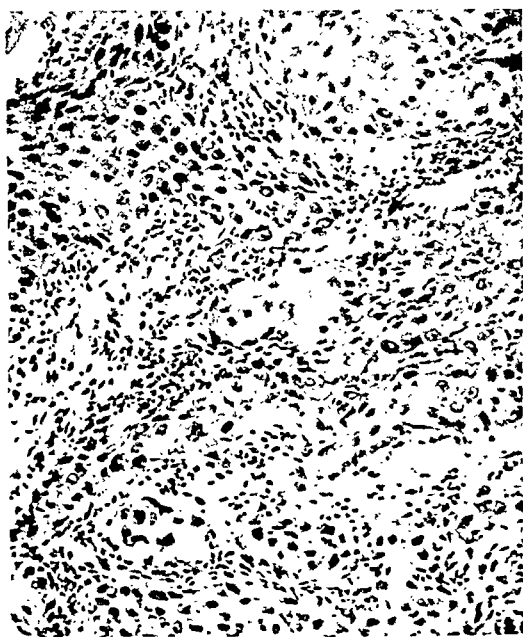


Fig. 5. Photomicrograph of section of lesion in Figure 3. Magnification 150 X.

meters and therefore the depth below the surface that each tubule is implanted, can be accurately measured. It is, perhaps,

than after the use of removable needles; (6) no residual pain due to the permanent presence of lead tubules in the tissues has been observed.

TABLE IX.—CAUSE OF DEATH IN 25 CASES

	No.
Carcinoma.....	22
Heart disease (two weeks after treatment)....	1
Lobar pneumonia.....	2
One died over four years after treatment; one died over three years after treatment; both clinically free of carcinoma at time of death.	

TABLE X.—CLINICAL CONDITION OF 14 CASES THAT ARE LIVING

	No.	Per-centage
Well over 6 years.....	4	28.5
Well over 4 years.....	1	7.4
Well over 3 years.....	3	21.4
Well over 2 years.....	4	28.5
Well over 1 year.....	1	7.4
Living over 2 years but in poor condition	1	7.4
Total.....	14	

needless to say that the tubules are sterilized by dipping them successively in 95 per cent carbolic acid, alcohol, and ether.

We usually draw a clock-faced diagram of the lesion and mark on the diagram the estimated points of insertion. After the routine implantation, one can go over the lesion and implant additional tubules at strategic points. The general rule of implanting approximately 1 mc. to each cubic centimeter of carcinomatous tissue has been followed. With small lesions, however, we deliberately overdose the lesion and the surrounding tissues; with large lesions, caution must be used not to give an excessive dose on account of the danger of severe radium necrosis. At the present time we seldom use less than a total of 15 mc. (30 tubules) or more than 35 mc. (70 tubules) in a single lesion.

Some of the advantages of lead radon tubules are: (1) there is no mortality due to the implantation; (2) hospitalization is seldom necessary; (3) there is less pain and discomfort than after most other methods; (4) sewing threads into the tongue is obviated; (5) recurrence in the tongue in our experience is less frequent



Fig. 6. Roentgenogram of patient in Figure 3 showing 25 lead radon tubules remaining permanently in tongue.

*Metastases.*—The difficulty of obtaining a clinical cure in carcinoma of the tongue lies not so much in the primary lesion as in the development of metastases.

*Non-palpable Nodes of the Neck.*—Some advocate block dissection in all operable cases; others do not operate in the absence of evident metastases. We use routine radium bomb treatment although we are not opposed to routine block dissection in dealing with ordinary squamous-cell carcinoma.

TABLE XI

*Clinical record:* Male, aged 69, first examined Jan. 9, 1935; severely ulcerated tongue lesion; right cervical nodes enlarged.

*Result:* Permanent resolution of tongue lesion; living but in poor condition from persistence of cervical metastasis.

Largest diameter of tongue lesion in cm.	Biopsy	No. tubules implanted in tongue lesion	Average strength of tubules in mc.	Total mc. implanted in tongue	Radium bomb to neck
7	Squamous-cell carcinoma Grade 2	100	0.48	48	28,000 mc.-hr. to neck at from 4 to 6 cm.

TABLE XII

Average size of tongue lesion and amount of treatment in seven cases: six with nodes, one without nodes; failure to eradicate tongue lesion; death from metastasis. One patient of this group had syphilis.

Average diameter of tongue lesion in cm.	Average no. of lead tubules implanted	Average strength of tubules in mc.	Average total mc. implanted in tongue	Radium bomb to neck
5	50	.67	33.5	Average 30,000 mc.-hr. at from 4 to 6 cm.

TABLE XIII

Average size of tongue lesion and amount of treatment in four cases: three with nodes, one without nodes; temporary resolution of tongue lesion with recurrence; death from metastasis. Two patients of this group had syphilis.

Average diameter of tongue lesion in cm.	Average no. of lead tubules implanted	Average strength of tubules in mc.	Average total mc. implanted in tongue	Radium bomb to neck
5	39	0.74	28.8	Average 26,000 mc.-hr. at from 4 to 6 cm.

TABLE XIV

Average size of tongue lesion and amount of treatment in 12 cases: 11 with nodes, one without nodes; permanent resolution of tongue lesion; death from metastasis.

Average diameter of tongue lesion in cm.	Average no. of lead tubules implanted	Average strength of tubules in mc.	Average total mc. implanted in tongue	Radium bomb to neck
5	38	0.71	26.9	Average 26,000 mc.-hr. at from 4 to 6 cm.

TABLE XV

Average size of tongue lesion and amount of treatment in two cases, both without nodes; permanent resolution of tongue lesion; one patient lived over four years, one over three years; death later from intercurrent disease; both clinically free of carcinoma.

Average diameter of tongue lesion in cm.	Average no. of lead tubules implanted	Average strength of tubules in mc.	Average total mc. implanted in tongue	Radium bomb to neck
	50	0.67	33.5	Average 24,000 mc.-hr. at from 4 to 6 cm.

TABLE XVI

Average size of tongue lesion and amount of treatment in 13 cases: five with nodes, eight without nodes; permanent resolution of tongue lesion and clinical recovery.

Average diameter of tongue lesion in cm.	Average no. of lead tubules implanted	Average strength of tubules in mc.	Average total mc. implanted in tongue	Radium bomb to neck
3	37	0.5 to 0.6	20.3	Average 24,000 mc.-hr. at from 4 to 6 cm.

*Palpable Nodes of the Neck.*—Surgical and radiological opinion appears to be greatly influenced by the type of carcinoma. With squamous-cell carcinoma with cell nests, excision is favored; with lympho- or transitional-cell epithelioma, irradiation is preferred. The results of excision, however, in cases in which nodes other than one submaxillary node are involved are not encouraging. If irradiations are used, we advocate surface irradiations with the radium bomb. There is some evidence indicating that a combination of radium and x-rays applied to the surface is superior to either agent used alone.

*Technic of Radium Treatment of Lymph Nodes of the Neck.*—Only surface irradiations are used: we do not favor radium or radon "puncture" of carcinomatous lymph nodes. At a distance of from 4 to 6 cm., the radium "bomb" containing a minimum of 1,000 mc. screened with 2 mm. of silver and from 4 to 6 cm. of balsa wood, may be applied daily. In the course of from four to six weeks from 24,000 to 36,000 mc.-hr. may be given to a skin area of 64 sq. cm. We avoid severe skin reactions whenever possible.

As we pointed out in 1926 (3), unless nodes are examined microscopically there is no absolute certainty that they are carcinomatous. Palpable nodes that resolve completely under irradiation we always

regard as inflammatory in the absence of microscopic evidence to the contrary.

*Results.*—From May 1, 1930, to May 1, 1936, we treated by the method outlined, 39 cases of carcinoma of the tongue which were diagnosed clinically and microscopically. Every case was treated without regard to statistics, but solely with the idea of relieving the patient. We would especially emphasize the fact that sufficient time has not elapsed to claim a permanent result except in a small proportion of cases. The results of treatment up to May 1, 1937, are noted in the accompanying tables.

For much help in the preparation of this paper, especially in connection with radon measurements and statistics, I wish to express my grateful thanks to my associates, Dr. J. E. Breed and Dr. J. S. Thompson.

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## ROENTGENOGRAPHY OF THE SECOND CERVICAL VERTEBRA BY OTTONELLO'S METHOD

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SINCE the description, in 1930, of a method of producing roentgenograms of the entire cervical spine in posterior projection on a single film by Ottonello (1), no information on its use was found in a search of the American literature. As, however, the value of this procedure is considerable, a brief descriptive note, with some suggested modifications, seems warranted.

Ottonello's view consists of a roentgenograph taken with the jaw in constant motion vertically, *i.e.*, by opening and shutting the mouth, the other factors being approximately the same as for the ordinary posterior view of the cervical spine. Several complete motions of the jaw must be made, open and shut, during the exposure, and an even, rhythmical motion is essential. In positioning the head, hyperexten-

sion of the neck is very important. If the head is flexed, the upper teeth will prevent the proper visualization of the topmost vertebræ. The study is best made in the recumbent position, with as great an F.S.D. as possible. In order to secure enough blackening of the film through the mandible, it is necessary to double the usual exposure, preferably by raising the voltage. This necessitates over-exposure of the remainder of the film, but two methods are available (not described in Ottonello's original communication) to minimize this. The best of these is to place a pure gum rubber bag filled about two-thirds full of water behind the shoulders and lower neck. It is essential that the bag shall not overlap the jaw in the lowest part of its excursion, as this will produce a blank strip across the film. The filtration of the bag will de-



Figs. 1 and 2. Roentgenograms of a cervical spine by the ordinary technic and by Ottonello's technic.





Figs. 3 and 4. Another pair showing less perfect visualization of C2 on the Ottonello view, due to incomplete extension of the head.

crease the exposure of the film in the lower cervical area enough to produce a satisfactory visualization. Another means of overcoming the difficulty is to use a filter, the upper third of which is 1 mm. Al, the second third, 2 mm., and the lower third, 3 mm. This is oriented with the thin part over the upper end of the spine. It will accomplish about the same thing as the water bag, but is not, of course, so plastic and is therefore less adaptable. The study is best made stereoscopically, and should, of course, be accompanied by a lateral projection.

With this method it is possible to show the second cervical vertebra and all vertebrae below it on the one film. In the writer's experience only the lower portion of the atlas and the dens are generally demonstrated; the upper portion of the atlas is almost never shown; sometimes the dens may also be obscured.

Routine employment of this method should be satisfactory whenever there is time available for careful positioning and drilling of the patient; but in a very busy

department it will be found less satisfactory, as considerable care is needed to produce uniformly good roentgenograms. As a supplementary examination, however, the study has certain points of superiority to the usual view through the open mouth. It can be employed with patients in whom the jaw cannot be widely opened, as required for the open-mouth technic. It gives a single view of the articulation of C1, C2, and C3 not to be obtained by the open-mouth study. It is also employable when the neck cannot be moved for positioning (as after trauma) to a greater extent than can other procedures.

The assistance of Dr. J. B. McAneny in checking the literature, and of Mr. Dudley Slauson in preparing the roentgenograms for reproduction, is gratefully acknowledged.

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# SENSITIZATION TO X-RADIATION BY THE DIRECT ELECTRIC CURRENT

By JOHN RUSSELL CARTY, M.D., *New York City*

IN a previous communication we discussed and reviewed the literature on artificial tissue sensitization to x-radiation. In addition, a preliminary report was made of some experimental work regarding the effects of ionization of irradiated tissue. These experiments have now been completed, and in view of the growing interest in artificial sensitization, it was felt the results might be of interest.

In order to fully comprehend the interaction of two essentially caustic agents on living tissue it is necessary to study the action of each agent alone. The action of the direct electric current may vary from a barely perceptible reaction to complete destruction of normal tissue. Generally

speaking, it is quite possible to pass current through living tissue without any demonstrable permanent change whatsoever, as is well known to the physiotherapist. The physico-chemical effects vary greatly at the opposite poles. For instance, the negative pole has an alkaline reaction, vasodilatation takes place, and there is irritation. At the positive pole there is an acid reaction and vasoconstriction, and there is sedation. Production of a certain amount of heat is probably common to both poles.

It has been shown that alkaline reaction, active vasodilatation, and irritation enhance the x-ray effect on normal living tissues. Acid reaction, vasoconstriction, and sedation, however, tend to decrease the effect.

If the current flux per unit tissue area is excessive, a burn may result. The electric current tends to travel where resistance is the least, *i.e.*, along blood vessels, lymphatic channels, etc., sometimes selecting structural planes in a manner which may be compared to that of a sandwich. For this reason an electric burn may actually be quite severe without much outward manifestation. The appearance of an electric burn complicates the evaluation of data tremendously, and every precaution was taken to avoid it. An electric burn is seen immediately after the electrode is removed. If at the negative pole, there is a soft wet eschar which is usually reddish. Under the positive pole the eschar is hard and dry, and is usually white in color. The histology is that of a necrotic process; the tissues taking the basophilic portion of the stain. The lesion usually begins to heal early, and results in a fairly insignificant scar. Unless the current has been very large the general health of the animal was unaffected.

If x-radiation alone is used, on the other hand, there is erythema, epilation, scaling, and ulceration if the dose is large. The



Fig. 1. Histological study of electric burn. Note the dark necrotic tissue with normal tissue above. This illustrates why an electric burn may be more serious than would be indicated on physical examination. Every precaution was taken during the experimental work to avoid the production of an electric burn.

histological changes are those of necrosis directly under the ulcer with fibrosis, endarteritis, etc. The necrosis is not of the selective character often noted with an electrical burn. The general health of the animal is affected, particularly if the treatment is over the abdominal wall.

In estimating the effect of combining the two agents, both gross and histological criteria were used. In the gross study the time of appearance of reaction, intensity of erythema, epilation, scaling, and ulceration were particularly noted. The general health of the animal was also considered. In the histological study, necrosis, fibrosis, cellular swelling, and endarteritis were looked for particularly.

*Details of Experiments.*—Large Belgian hares were used, and, with a few exceptions, the abdominal wall was chosen for the experimental area. The latter was shaved carefully, avoiding nicks in the skin. If a nick occurred it was covered with colodion. The electric current was derived from 110-volt direct current lighting circuit. Voltage and milliamperage were controlled by a circular graphite, continuous resistance rheostat in series with a 16-watt 110 volt lamp. A milliammeter reading zero to 10 and a voltmeter reading zero to 120 were placed in the output circuit. The electrode consisted of platinum gauze or wire surrounded by surgical gauze moistened in isotonic saline solution. In this manner possible confusing effects due to polarization were avoided. X-radiation was generated by pulsating outfits, one of which had a mechanical rectifier and the other a valve rectification (full wave). Target distance was 20 cm., using unfiltered radiation. Means were taken to dissipate the heat emitted from the target. Intensity measurements were made in air with a Victoreen r-meter which had been checked against a large chamber instrument.

A protocol typical of each group of experiments will be given.

An area on the abdominal wall of the rabbit was prepared. The entire area was irradiated until 2,000 r units were given



Fig. 2. Note the shaved area on the abdomen. The negative electrode was placed on the upper half of the area immediately after the entire area had been irradiated with x-ray 45 days previously. Note the marked reaction under the electrode. The x-ray reaction on the control area is barely visible.

over the upper half; the positive pole was then placed over the upper half of the area, the lower serving as a control. A current of 5 milliamperes at 30 volts was passed for 45 minutes. Immediately after removal of the electrode there was no evidence of ulceration but there was vasodilatation. Two days after irradiation a soft ulcer was noted where the negative pole had been applied.



Fig. 3. Longitudinal section from the margin of the sensitized area through the control area, of animal shown in Figure 2. The limits of the negative electrode are indicated by the margin of the necrosis on the right. Note the marked fibrosis in the mid-portion of the section, with less pronounced post-radiation findings to the left.

7 days—marked reddening about the edge of eschar and extending slightly beyond the limits of the electrode. The control appeared normal.

14 days—several scaly patches appeared in the reddened area. The control was normal. Animal showed emaciation and toxicity.

48 days—eschar started to heal, the control showing a slight reddening.

60 days—scar had formed with a hard mass in the subcutaneous tissue under the scar. The control appeared normal.

The experiment was repeated with the ionization given before, and then during,

the irradiation. Ionization with the positive pole was then done under the above experimental conditions.

In order to demonstrate the effect of intensity of current flow, the flowing experiment was completed:

An electrode consisting of a platinum wire in contact with several layers of surgical gauze was placed across the end of the right ear of a rabbit to form a positive pole. The gauze was moistened with normal saline solution. A large dispersive electrode was placed on the back. The left ear served as a control and the end was similarly clamped between tongue depressors. This was done to avoid errors which might be caused by blocking of the venous flow. Four milliamperes at a voltage of 30 was passed through the ear for four minutes before irradiating. X-radiation was then applied for 25 minutes while the current was still flowing. Toward the end of the radiation period the milliamperage had risen to 5.5 while the voltage had dropped to 28, indicating a lessened resistance. Both current and radiation were then discontinued. The target of the Coolidge tube was scattered midway between the ears. Target-skin distance was 8 inches: 1,500 r units were given at 100 kv.p. unfiltered.

16 days post-radiation there was marked epilation and marked erythema at the base of the right ear. The left ear appeared normal.

24 days—right ear was red near the body. There were scattered scaly patches and there was marked epilation. A slight epilation was noted on the control ear.

35 days—right ear felt cold. There was venous thrombosis. Left ear was normal to touch.

This experiment was repeated using the negative pole on the right ear instead of the positive. The experiments were repeated to a total of six, using the negative pole three times and the positive pole three times. In one instance in which the positive pole was used no difference could be detected between the two ears.

*Interpretation of Results.*—In normal rabbit tissue the negative pole consistently showed a greater reaction than that of the control area, indicating a definite sensitization. The control area does not merge histologically in an abrupt manner with that of the area under the electrode. We constantly found a peripheral zone where

The experiments with the rabbit ear are interesting and suggestive, and indicate that the sensitization may possibly not depend entirely on the local polar effects.

#### CONCLUSIONS

The direct electric current can produce sensitization to x-radiation in normal rab-



Fig. 4. Possible effect of current flux. Note marked epilation at the base of right ear. There is only slight epilation on the left. An area including the medial halves of the ears was irradiated at one sitting, while the negative electrode was placed at the tip of the right ear and a current passed through. Note the roughly triangular area of epilation which corresponds with an increase of current flux per unit tissue area.

the sensitization was definite but less intense than in the area immediately under the electrode. The positive pole, however, showed inconstant results; if anything, the reaction was slightly diminished. Greater sensitization was obtained when the ionization and irradiation were simultaneously applied. Provided the time interval was the same, no appreciable difference was noted between the pre- and post-radiation and application of the electrode.

bit tissue, producing a local, intense reaction which gradually fades beyond the limit of the electrode. The use of this agent to intensify the effect of external radiation in the treatment of malignant disease has at least a logical as well as an experimental background.

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# THE ROENTGENOGRAPHIC DEMONSTRATION OF THE PULMONARY VEINS

By BERNARD S. EPSTEIN, M.D., *Brooklyn, N. Y.*

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ROENTGENOGRAPHIC demonstration of the pulmonary veins has received less attention than the pulmonary arteries because their anatomical distribution and comparatively delicate structure render them inconspicuous as compared to the more dense neighboring structures on routine teleoroentgenograms.

In order to study the position of the left auricle and pulmonary veins more adequately, postmortem roentgenograms were made of the chest after injection of a suspension of barium sulphate in water. The left auricular appendage was entered after resection of the left fourth, fifth, and sixth costal cartilages, and a catheter was fixed *in situ*. The heart then was allowed to fall back into its resting position, and the chest was closed. The amount of barium injected and the pressure used were controlled by fluoroscopic observation of the injection. Films were taken with the cadaver in the prone position at a four-foot target-film distance. Roentgenographic studies also were made of injections into the right auricle, ventricle, and pulmonary arterial bed through the superior vena cava, and of injections into the arterial and venous system of the lungs.

The studies were controlled further by examination of the contents of the pulmonary arteries or veins after the roentgenograms had been developed to determine whether barium had entered the arteries after a venous injection or *vice versa*.

The findings derived from the films compared favorably with those published by Cottenot, de Balsac, and their collaborators (1), who observed more elaborate precautions to simulate conditions existent during life. Their injections were made through the great vessels in the neck, and films were taken in the erect position at a

six-meter target-film distance after reinflation of the lungs.

The pulmonary veins were seen parallel with the arteries in the distal two-thirds of the lung-fields on the injection roentgenograms. At the junction of the middle and inner thirds of the pulmonary beds the veins and arteries separated, the former proceeding to the lateral borders of the left auricle, the latter to the main trunks of the pulmonary arteries. The pulmonary veins united to form two or three main trunks which penetrated the pericardium and entered the posterolateral aspects of the left auricle. Occasionally the main trunks united within the pericardial sac and entered the left auricle as a single lumen. No venous valves were present.

The length of the main venous trunks in the paracardiac region was variable. As a rule the trunks were not more than two or three centimeters long, and subdivided into their secondary branches more abruptly than the pulmonary arteries. At no place in the parenchyma did the larger pulmonary veins approximate the size and thickness of the larger pulmonary arteries.

In general, postmortem injection experiments are open to the criticism that conditions found at autopsy differ from anatomical relationships present during life. Therefore, a final statement concerning the location of the left auricle and pulmonary veins could not be made until they had been visualized in the living individual. It remained necessary to demonstrate the location of the pulmonary veins as they entered the left auricle in patients with normal and abnormal hearts, and compare the findings with the injected preparations.

This was made possible by the planigraphic devices described by Twining (2)

and Alexander (3). By simultaneously moving the film carriage and x-ray tube stand proportionally in opposite directions a

attached to the tube stand and Bucky carriage, respectively. The fulcrum of the lever is movable so that the ratio of move-

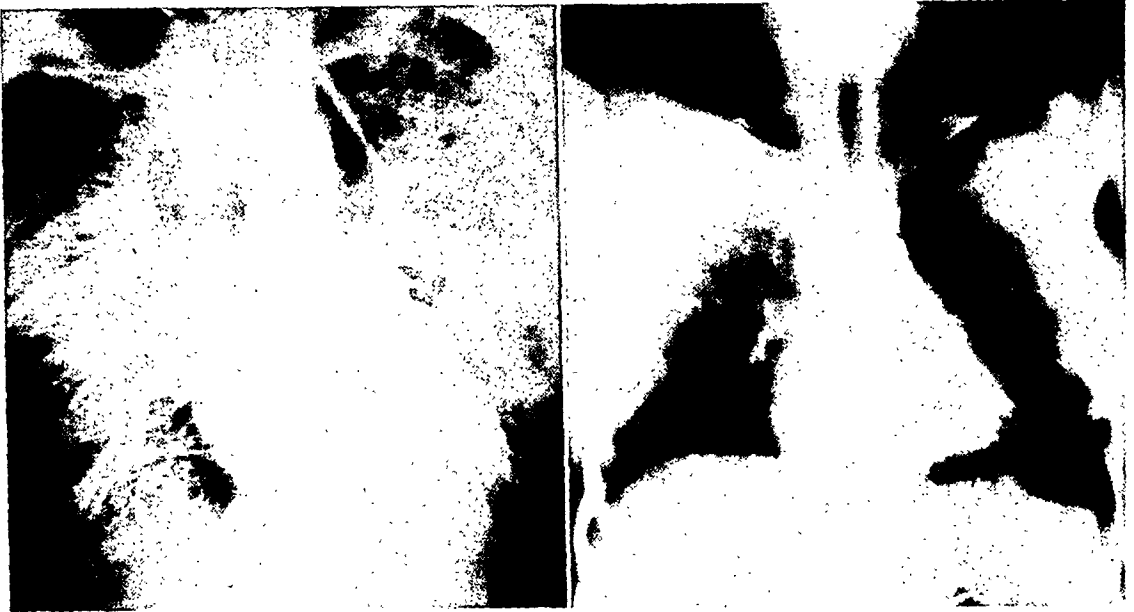


Fig. 1-A (left). Postmortem injection of the left auricle and pulmonary veins (heavy black lines in sketch) in a 26-year-old woman who died because of a brain tumor. Some barium has entered the ascending aorta (barred lines in sketch).

Fig. 1-B (right). Planigraphic film of the chest of a healthy woman of 27 of the same height and weight. The pulmonary veins are seen entering both the right and left borders of the left auricle. The pulmonary arterial tree (parallel lines in sketch) is seen also. The black dots in the sketch represent vascular branches cut transversely. The technic of over-penetration was used for this film.

single plane parallel to the film within an object such as the chest may be visualized.

Twining's device utilizes an eccentric lever of the first class whose ends are

ment between the tube and film can be varied. Alexander's device employs a system of pulleys moving the Bucky carriage and tube stand in opposite directions.

On the postmortem injection films the size and distribution of the right pulmonary veins were seen better in the right anterior oblique projection than in the postero-anterior projection, and corresponded in size and distribution to those seen in the living patient.

The arterial tree in that plane could be seen in detail on the planigram. The veins and arteries began to course in parallel direction approximately at the junction of the inner and middle thirds of the lung fields. In the mesial third of the right lung field the pulmonary veins separated from the arteries and gathered into large main branches to enter the right cardiac border as described.

After these studies were made, a number of roentgenographic studies of the heart made in the postero-anterior, right anterior oblique, and left anterior oblique projections were re-examined. In many of these the pulmonary veins could be seen faintly but definitely. On the oblique films, especially those made in the left anterior oblique projection, shadows of increased density could be demonstrated below the left main bronchus. Comparison of these shadows with roentgenograms of the injected preparations made in similar positions indicated the strong possibility that the infra-bronchial shadows were cast by the pulmonary veins.

## SUMMARY

Roentgenographic studies were made of injections of the left auricle and pulmonary veins with the organs *in situ* in a cadaver with a normal heart and a second cadaver with rheumatic heart disease. These were compared with planigraphic studies of the chest of two living persons with similar cardiac conditions. The cases were chosen so that the films were comparable.

The location of the pulmonary veins and left auricle in the postmortem preparations corresponded with that of the living individuals.

The pulmonary veins and arteries can be studied more advantageously in planigraphic x-ray examinations of the chest than in ordinary roentgenograms. It now should be possible to study the condition of the pulmonary veins more thoroughly.

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# EMPHYSEMATOUS CHOLECYSTITIS AND PERICHOLECYSTITIS<sup>1</sup>

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FOR many years it has been an axiom accepted by the majority of roentgenologists that, without the aid of a contrast medium, the normal gall bladder cannot be definitely visualized in the roentgenogram. Any visualization in the flat plate is, therefore, attributed to pathologic factors: thickening of the gall-bladder wall in certain forms of cholecystitis; calcifications in the wall in "porcelain gall bladder"; calculi in cholelithiasis; inspissation of bile or sedimentation of amorphous calcium carbonate in the so-called "calcium milk bile" (*Kalkmilchgalle*) and similar factors.

In my search of the radiological literature I have failed to find any references to the visualization of the gall bladder by spontaneous gas-filling as it is encountered in gaseous or emphysematous cholecystitis. This omission appears the more unusual when we consider that not only is the presence of gas-forming bacteria in the biliary system a common occurrence, but also that this condition has been described often both by surgeons and pathologists.

The first references to emphysematous cholecystitis date back to the beginning of the present century. In 1901, Stolz (1) reported three cases in which, at autopsy, gas was discovered in the gall bladder. In 1925, Kirchmayr (2) described a case of emphysematous cholecystitis diagnosed during cholecystectomy. Two years later, Wahlberg (3) published four cases of gas bacillus infection observed in 1,000 gall-bladder operations. This material included two cases previously reported by Brütt (4). While, however, Brütt had been able to recognize gaseous cholecystitis during operation, Wahlberg's diagnoses were based exclusively on post-operative bacteriologic findings.

It lies beyond the scope of this paper to enter the discussion concerning the rather complicated and by no means undisputed problem of the bacteriology of gall-bladder disease. Suffice it to say that the percentage of positive bacterial findings in gall-bladder disease is high, though it varies within wide limits in different reports. A recent review of 2,162 cases of cholecystitis studied bacteriologically after cholecystectomy and published by Rehfuß and Nelson (5), sets the average figure for positive bacterial cultures from the gall-bladder wall at more than 45 per cent and the positive cultures from the gall-bladder contents (bile) at about 30 per cent.

I shall confine myself to a brief résumé of the bacteriologic findings as far as they apply to emphysematous cholecystitis.

In all cases reported by Stolz, *B. coli communis*, *B. lactis aerogenes*, and various aerobic sporulating bacilli were recovered. In one case, a non-pathogenic diphtheroid and *Staphylococcus pyogenes aureus* were also found. However, cultures for obligate anaerobes were negative. In Brütt's and Kirchmayr's cases, Fränkel's gas bacillus was isolated and was considered the cause of the emphysematous bile changes. The same observations were made and similar conclusions were reached in Wahlberg's cases. In several cases mentioned in the literature the identification of the bacteria meets with considerable difficulty, partly due to the lack of definite description and partly to widely varying classification and nomenclature. Fränkel's gas bacillus is, for example, identical with *B. welchii*, which latter term is used with preference in America, but the correct and bacteriologically approved term for this organism is now *B. perfringens*. It is no rarity that the same bacillus is described under three or four different names by different authors, which fact, of course, is rather confusing

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

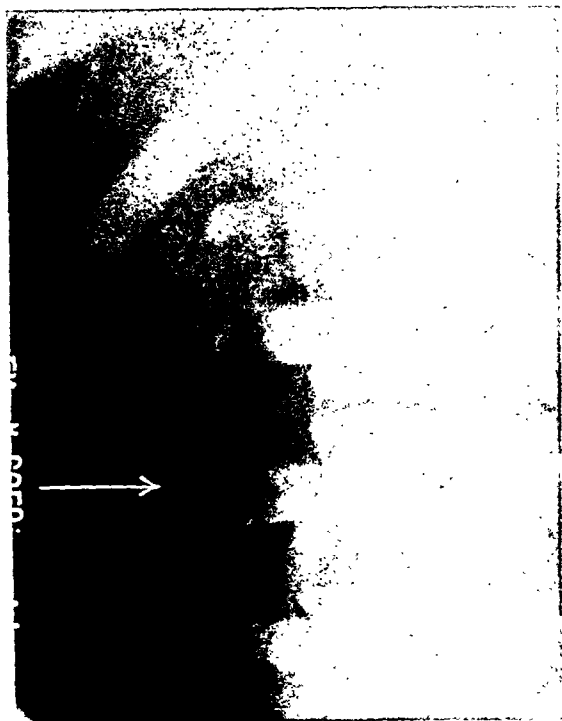


Fig. 1. Gas-filled gall bladder before cholecystography (Case 1).

for both bacteriologists and non-bacteriologists. Of gas-forming bacteria, *B. coli communis* is most frequently encountered in the gall bladder (in 11 to 16 per cent of the cases, according to Andrews and Henry), next *B. perfringens* (in 9 to 11 per cent of the cases, 6).

The first of our cases, J. C., a miner, 37 years of age, was admitted to the Colorado General Hospital on account of periodically recurring pains in the right upper abdominal quadrant combined with intermittent attacks of fever. These attacks had been observed for approximately three years and had been clinically diagnosed as due to cholecystitis. Outside of marked tenderness in the gall-bladder region the clinical examination was essentially negative. Gastric analysis showed low acidity (free HCl 16; total acidity 28). The blood examination yielded normal figures for hemoglobin, erythrocytes, and leukocytes, but a high polymorphonuclear percentage (85 per cent) and a low lymphocyte count (about 9 per cent). Examinations for malaria parasites and tubercle bacilli, as well as Wasser-

mann reaction, were negative. The evening temperatures rose to about 103° F., the pulse rates to 118. There was no evidence of jaundice.

The x-ray examination before cholecystography revealed an elongated gas-filled area in the right hypochondrium corresponding in location to the point of maximum tenderness and suggesting in shape and outlines a slender gas-filled gall bladder (Fig. 1).

Cholecystography showed this identical area definitely, though faintly, filled with gall-bladder dye (Fig. 2).

Further examinations after barium meal and enema definitely excluded gas accumulations in the gastro-intestinal tract, especially in duodenum and colon, as sources of the reported shadow.

The final x-ray diagnosis was: Gas filling of poorly functioning gall bladder, apparently due to emphysematous cholecystitis.

Under a dietary régime and bed rest the patient improved rapidly so that surgical intervention was deemed unnecessary. At the time of this report he is without symptoms and feeling well.

The second case, confirmed by operation and necropsy, has already been published in the surgical literature (7) by the surgeon, Dr. C. F. Hegner, Professor of Surgery of the University of Colorado School of Medicine, and I am greatly indebted to Dr. Hegner for his permission to use his data in the case.

This case was observed in a farmer, J. L., 62 years of age, who complained of recurring attacks of pain in the right hypochondrium. These attacks had, at the time of admission to the Colorado General Hospital, lasted for about five days and were accompanied by the vomiting of bile-colored fluid. Jaundice had developed two days after onset of symptoms and was, at admission, marked in both skin and sclera. The right upper abdominal quadrant was slightly rigid and decidedly tender. The patient did not appear acutely ill although his temperature occasionally reached 102° F. The blood count showed:

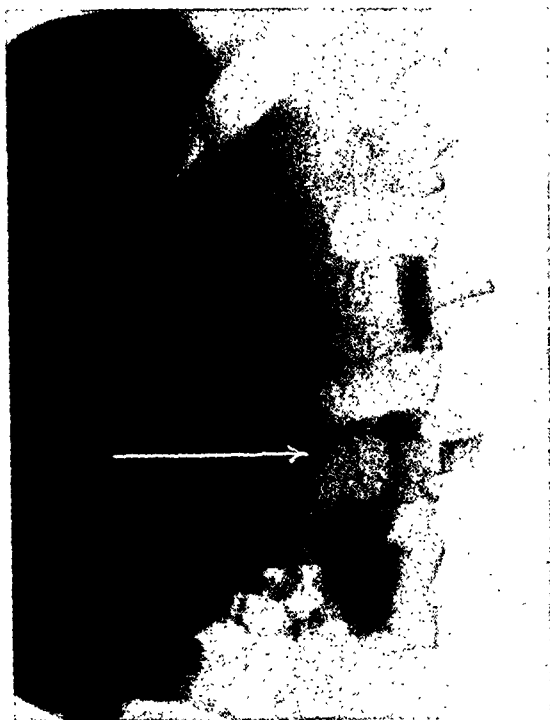


Fig. 2. Visualization of gall bladder after cholecystography (Case 1).



Fig. 3. Gas-filled gall bladder with gas streaks in pericholecystic area (Case 2).

erythrocytes 4,910,000; leukocytes 14,100 of which 90 per cent were polymorphonuclears and 10 per cent lymphocytes. Pulse rate was 92; blood pressure 136/76. Wassermann reaction was negative.

The x-ray examination of the gall bladder (intravenous cholecystography) showed a large pear-shaped, well-circumscribed area of gas accumulation in the right hypochondrium. In location, size, and contours this area suggested a large gas-filled gall bladder and the diagnosis of emphysematous cholecystitis was given. A series of concentric gas streaks in the surrounding tissue seemed to point to pericholecystic extension of the emphysema (Fig. 3).

A later x-ray examination of the gastrointestinal tract showed a constant deformity of the duodenal bulb, apparently due to extrinsic (gall-bladder) pressure.

This area was tender on pressure and tympanitic on percussion.

Exploratory laparotomy was performed one week after admission. Colon, omentum, duodenum, and stomach were found to be intimately adherent to the margin

of the liver and the region of the gall bladder. A soft friable mass was felt in this area into which a needle of a 20 c.c. syringe was introduced. The syringe immediately filled up with gas under pressure sufficient to push the plunger out of the barrel. This procedure was repeated several times. The outlines of the gall bladder were rather indistinct. No biliary calculi were palpated and it was considered advisable only to drain the gall bladder. A rubber tube was inserted into the supposed gall-bladder cavity. The patient left the operating table in good condition. A post-operative rise in temperature was successfully combated by the injection of Cutter's triple anaerobic serum. The composition of this serum is similar to that which was used by the French against gas gangrene in the World War. The patient seemed well on the way to an uneventful recovery, when, suddenly, on the fourth post-operative day, he died of pulmonary embolism.

The autopsy findings (Dr. W. C. Johnson) are summarized in the following anatomical diagnoses: "Suppurative chole-



Fig. 4. Microscopic slide preparation from anaerobic blood agar slant demonstrating micro-organism found in Case 2. Gram stain; magnification, 1,200 times.

cystitis and pericholecystitis, cholelithiasis, necrosis with perforation of the neck of the gall bladder, slight biliary cirrhosis of the liver, chronic inflammation and fibrosis of the liver adjacent to the gall bladder, thrombosis of the external and internal iliac veins, and pulmonary embolism, the latter being considered the cause of death."

The microscopic examination of the gall bladder showed loss of nuclear stain; the coat of the gall bladder was thickened and studded with yellow bile pigment. Sections of the wall showed few long filamentous Gram-negative organisms. No condition comparable to "foam liver" (*Schaumleber*), as described by some authors in gas bacillus infections, was noted.

The bacteriological examination was done by Dr. I. C. Hall and extended to specimens both antemortem and post-mortem.

A specimen of bloody material taken from the gall-bladder area during the

operation showed microscopically a few polymorphonuclear leukocytes but no bacteria. However, a gas-forming bacillus somewhat resembling *B. perfringens* was recovered in the cultures (Fig. 4). The same organism was found in a second specimen also taken from the supposed gall-bladder cavity. This organism resembled *B. perfringens* in its physiology but was somewhat atypical in morphology. The cultures were tested for pathogenicity in a guinea-pig and found to produce moderate edema with some emphysema. In a control pig the edema was prevented by 1 c.c. of Cutter's triple anaerobic serum.

A blood culture taken about three hours after operation was negative.

The heart blood taken postmortem proved sterile.

The extravasated bile, dark green and thick, from the site of operation showed microscopically numerous pus cells and Gram-positive filaments and rods resembling those isolated at the operation, but, owing to an invasion by various intestinal bacteria, it was impossible again to isolate the organism found during the operation.

A few words may not be amiss concerning the possible routes of bacterial invasion in gall-bladder disease, especially in emphysematous cholecystitis.

Theoretically these routes may be: (1) the blood or lymph streams; (2) direct extension from neighboring organs or from adhesions; (3) the bile passages either descending from the liver or ascending from the duodenum.

While Gilbert and Lippman (8), in 1902, still considered the ascending infection from the duodenum the route *par excellence*, later investigators have laid increasing emphasis on the other possibilities, *i.e.*, blood and lymph circulation or direct extension. Certain conclusions may possibly be drawn from the type of bacteria encountered. According to Refhuss and Nelson, the bacterial flora of the diseased gall bladder may be roughly divided into a "head group" and a "bowel group." To the first group belong bacteria which are usually found in foci of the head, *e.g.*, in

pyorrhea, tooth infections, tonsillitis, sinus disease, etc., in other words, primarily bacteria of the *Streptococcus viridans* family. The second group comprises micro-organisms habitually found in the gastro-intestinal tract, i.e., the colon-typhoid group and gas-producing bacteria. While, nowadays, most authors seem to be agreed on the predominance of blood-borne infection in gall-bladder disease, thus giving preference to the bacteria of the "head group," the other routes of invasion must not be overlooked. The observation of barium in the gall bladder after oral barium administration and the experiments of Bond (9), who was able to demonstrate the presence of charcoal in the gall bladder after rectal administration, show the importance of ascending infection from the duodenum, probably in cases of impairment of the sphincter of Oddi.

The question of relative significance of gall-bladder wall to gall-bladder contents for the localization and isolation of bacteria, as well as the relative rôle of the different bacteria in the causation of cholecystitis, have led to lively polemics and are still far from being solved.

In our cases, too, any opinion concerning the way of infection can be only speculative.

In neither case, definite foci of infection outside the gall-bladder area could be established. In Case 1 the gas accumulation was confined to the gall bladder proper. In Case 2 the sequence of roentgenograms seemed to prove that the initial infection and gas accumulation developed in the gall bladder and only secondarily extended to the pericholecystic region.

No definite observations or facts can be adduced to prove or disprove an ascending infection from the duodenum. However, in my opinion, this should be considered

the route of choice in emphysematous cholecystitis, not only because the gas-forming bacteria belong to the above-mentioned "bowel group" but also because, specifically in our cases, the negative blood cultures and the absence of gas bacillus infection in other parts of the body militate against the conception of blood-borne bacterial invasion.

To what extent the apparently favorable influence of the anaerobic serum and the striking lymphopenia in both cases may be utilized for diagnostic conclusions is open to discussion.

On account of the limited number of cases, it cannot be my intention to present a definite and well-rounded pathological entity at the present time. The only purpose of this paper is to call the attention of the radiological profession to a picture which so far has escaped mention in our literature but which apparently well deserves to be added to the roentgenological criteria of gall-bladder disease.

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# EFFECTS OF ROENTGEN RAYS ON THE ACTIVATION AND PRODUCTION OF THE ENZYME TYROSINASE IN THE INSECT EGG (*ORTHOPTERA*)<sup>1, 2</sup>

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## INTRODUCTION

MOST investigations on radiant energy in relation to enzymes indicate that enzymes are affected by various types of radiations. Sunlight and ultraviolet radiation have been used extensively and result, for the most part, in varying degrees of inactivation with an occasional report of stimulation (Duggar, 8). The situation in regard to the effects of roentgen rays is similar. Inactivation, more or less resembling the effects of heat, is often reported (Clark and Northrop, 7). In a few instances, acceleration has been obtained by short exposures, with inactivation only after extensive x-irradiation (Richards, 15). The action of radium rays on digestive enzymes has been investigated and found to result in destruction of their activity (Henri and Mayer, 10).

Experimental studies on the effects of visible and ultra-violet rays on the enzyme, tyrosinase, demonstrate that it also is altered by irradiation. In two instances it has been reported that the activity of this enzyme was greatly reduced by exposure to ultra-violet rays (Pincussen and Hammerich, 13; Agulhon, 1). It has also been shown (Agulhon, 2; Przibram and Dembowski, 14) that visible light destroys tyrosinase only in the presence of oxygen, and it is suggested (Przibram and Dembowski, 14) that the destruction may be due to the formation of hydrogen peroxide, inasmuch as ultra-violet rays do not destroy the en-

zyme's activity when it is dissolved in glycerin. In more recent investigations (Narayanamurti and Ayyar, 11; 12) the slightly increased activity after ultra-violet irradiation is explained as being due to a decrease in the negative charge of the enzyme permitting increased adsorption catalysis. It has also been shown (Willcock, 17) that tyrosinase is an exception to the rule in that it is not affected by exposure to beta and gamma rays of radium. In view of these considerations it was thought that the effects of roentgen radiations on tyrosinase might be of interest, and it is the purpose of the present paper to present results of a study on the effects of roentgen rays on the activity of the enzyme and on its production in the developing orthopteran egg.

## MATERIAL AND METHODS

Several features that make the eggs of the grasshopper, *Melanoplus differentialis*, desirable for use in an investigation of this kind have previously been pointed out (Bodine, 3). The effects of roentgen irradiation on both tyrosinase solutions and eggs were determined. Eggs of varying ages throughout both developmental periods (pre-diapause and post-diapause of 18 days each) as well as during the intervening inactive period (three to four months at 0° C.) were irradiated.

The preparation of the enzyme solution was similar to that of Bodine, Allen, and Boell, (5). Briefly, it was as follows: 60 to 200 eggs were washed in tap water; sterilized in 70 per cent alcohol for ten minutes; washed three times in sterile, distilled water; washed twice in buffered NaCl solution (50 c.c. 0.9 per cent NaCl; 25 c.c. M/15 Na<sub>2</sub>HPO<sub>4</sub>; 25 c.c. M/15 KH<sub>2</sub>PO<sub>4</sub>) of pH 6.8; transferred to a sterile

<sup>1</sup> Aided by a grant from the Committee on Radiation of the National Research Council and by the Rockefeller Foundation Fund for Research on the Physiology of the Cell.

<sup>2</sup> The author wishes to express his appreciation to Professor J. H. Bodine for the manifest interest and many helpful suggestions rendered during the progress of this investigation.

<sup>3</sup> Unpublished observations of Dr. E. E. Carothers.

glass mortar and thoroughly ground. The mixture was poured into a sterile graduated centrifuge tube with rinsings of the mortar with buffered NaCl to bring the total to a concentration of 20 eggs per c.c., not including the shells of the eggs (approx. 0.5 c.c.). Centrifuging for five minutes at 1,000 r.p.m. separated this brei into three layers previously designated (Bodine, Allen, and Boell, 5) as *A*, *B*, and *C*. *A* was a thin lipoidal, surface layer. *B* constituted the major portion containing almost all of the tyrosinase. *C*, approximately 0.5 c.c., was at the bottom and included the egg shells, etc. Layer *A* was pipetted off and layer *B* was used for the determination of tyrosinase activity of irradiated eggs. For the irradiation of tyrosinase in solution the proteins were precipitated from layer *B*, leaving a supernatant fluid designated as *B*<sub>1</sub> (Bodine, Allen, and Boell, 6). This solution retained its activity for several weeks when kept at 0° C.

Tyramine-HCl was used as substrate in such concentration that 388 c.mm. of oxygen are utilized by the tyrosinase in complete oxidation of 0.3 c.c. of the solution (Bodine and Boell, 4). The supply of the substrate was kept at 0° C. to prevent autoxidation.

An investigation of the activation of tyrosinase from the orthopteran egg has been conducted (Bodine and Allen, 6) and it has been demonstrated that there is an activating substance occurring naturally in the egg. It was further discovered that in centrifugation of egg brei the natural activator was segregated in the top layer (*A*) and could be removed with a pipette. This left an extremely inactive preparation of tyrosinase (layer *B*), as indicated by the negligible amount of oxygen uptake when the substrate was added. Of many compounds tried in a search for artificial activators it was found that sodium oleate, at a final concentration of from 0.05 to 0.1 per cent, gave the maximum and most immediate activation of the enzyme. For this reason it was used as activator in this investigation.

It is to be noted that there are both ac-

tive and inactive forms of tyrosinase on which to determine the effects of roentgen rays. Omission of the activator (0.1 c.c. 2 per cent sodium oleate) from the manometer flask permits ready detection of any activation due to roentgen irradiation, while the activated enzyme should show any inhibition or destruction of activity resulting from roentgen rays.

Determinations of enzyme activity were carried out in standard Warburg manometers at 25° C. In a typical experiment the various reagents were arranged as follows: 1 c.c. of *B* or *B*<sub>1</sub> (containing tyrosinase from 20 eggs); 0.1 c.c. of 2 per cent sodium oleate; 0.1 c.c. of 10 per cent potassium hydroxide (center well); 1.6 c.c. of buffered (pH 6.8) 0.9 per cent sodium chloride; 0.3 c.c. of 0.4 per cent tyramine HCl (in the side bulb). A manometer flask containing no tyrosinase served as a thermobarometer. In preliminary experiments it was determined that no detectable autoxidation of the substrate occurred. The activity of the tyrosinase was thus determined from the rate of oxygen uptake.

The roentgen apparatus used was a double cross arm mechanically rectified unit energizing a Coolidge broad focus universal air-cooled tube at 130 kv.p. and 5 ma. The eggs were irradiated on several layers of moist filter paper in a petri dish and, for doses of 10,000 r or less, were given 200 r per minute at 25 cm. distance. For greater doses the distance was 15 cm. and the reception was 554 r per minute. The intensity was measured by means of a commercial dosimeter filtered through 2 mm. of cardboard. Doses of 100,000 r or more were given in two exposures not more than 24 hours apart. Tyrosinase extracts were also irradiated in petri dishes. In no instance did the temperature of the material exceed 27° C. during irradiation.

## RESULTS

1. *Effects of Roentgen Rays on the Activity of Tyrosinase Solutions.*—The tyrosinase solution used in these experiments was that previously described as *E*<sub>1</sub>. It was entirely satisfactory in that it suffered no

apparent physical change after rather prolonged irradiation. Attempts to use the B fraction were unsuccessful, due to the

precipitation of proteins during irradiation making it difficult to pipette.

It should be explained that the time in-

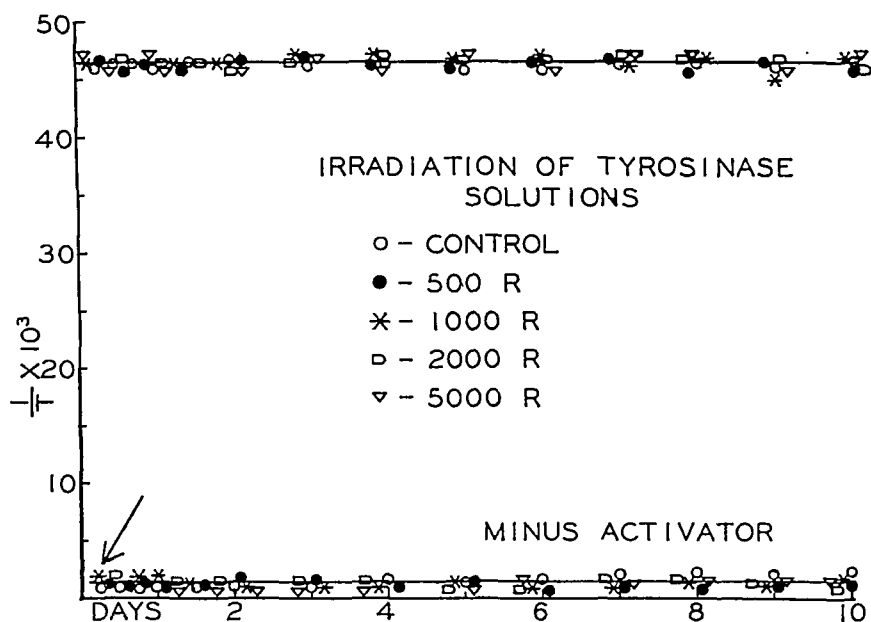
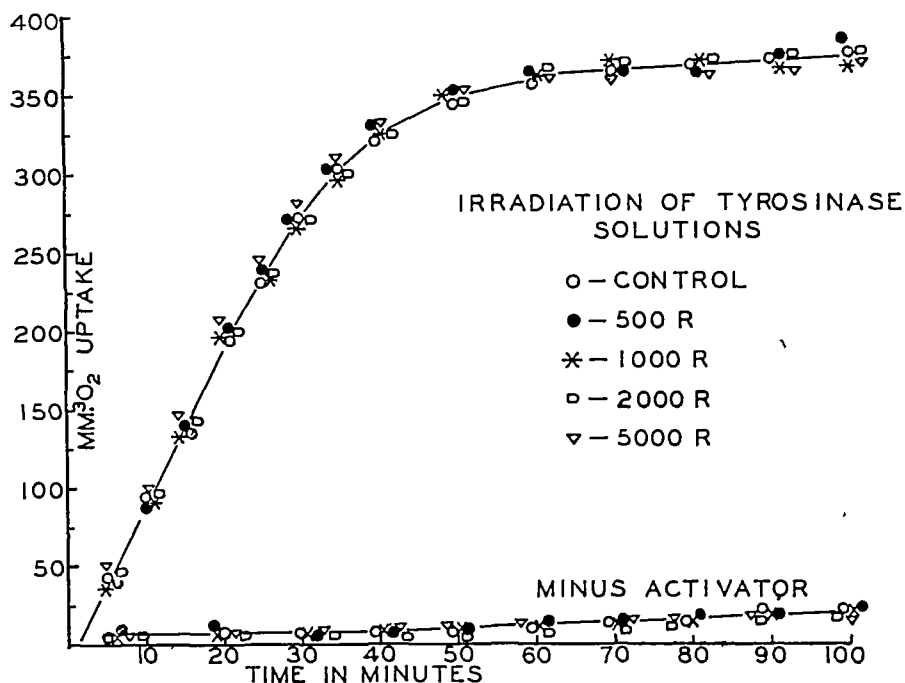


Fig. 1 (above). The effects of roentgen radiation of tyrosinase solutions prepared from the eggs of the grasshopper, *M. differentialis*. The first part of the upper curve represents the activity of the activated enzyme. Ordinate, mm.<sup>3</sup> total oxygen uptake; abscissa, time in minutes from the addition of the substrate.

Fig. 2 (below). Effects of roentgen radiation of tyrosinase solutions prepared from grasshopper eggs. Upper curve represents activated enzyme. Arrow indicates point of irradiation; ordinate, reciprocal of time for half life; abscissa, days from irradiation.



terval between completion of the irradiation and beginning of manometric measurements was kept at 10 minutes in all cases.

The results of typical series of such ex-

periments are presented in Figure 1. From the upper curve it may be seen that there is no inactivation of the tyrosinase by roentgen rays in the amounts given. During the first 20 minutes the activity is a function of the enzyme, not of the substrate concentration, and the points representing exposures of 500 to 5,000 r are nearly superimposed. If the activity of the enzyme had been partially destroyed, the slopes of the curves representing irradiated tyrosinase would have been lessened.

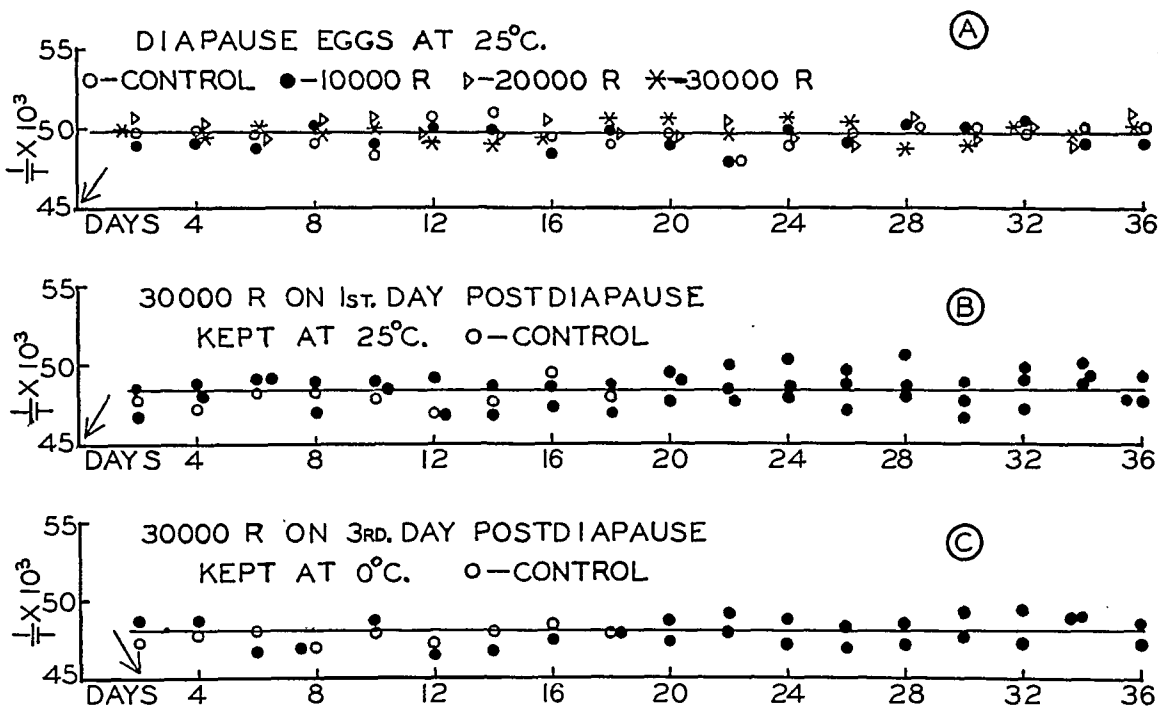


Fig. 3. Effects of roentgen irradiation of the eggs of *M. differentialis* on the activity of the contained tyrosinase. A represents enzyme from non-developing eggs; B, enzyme from developing eggs, and C, tyrosinase from developing eggs kept at low temperature to prevent further development. Curves representing non-activated tyrosinase were omitted to conserve space. Arrows indicate day of irradiation; ordinates, reciprocal of time for half life; abscissae, days of development at 25° C.

periments are presented in Figure 1. From the upper curve it may be seen that there is no inactivation of the tyrosinase by roentgen rays in the amounts given. During the first 20 minutes the activity is a function of the enzyme, not of the substrate concentration, and the points representing exposures of 500 to 5,000 r are nearly superimposed. If the activity of the enzyme had been partially destroyed, the slopes of the curves representing irradiated tyrosinase would have been lessened.

The lower curve in Figure 1 demonstrates the extreme inactivity of the tyrosinase when the sodium oleate is omitted. This non-activated enzyme shows less than 5 per cent of the oxygen uptake occurring

The ordinates of the following graphs were determined as the reciprocal of the time in minutes to utilize half of the theoretical total amount of oxygen multiplied by  $10^3$ .

That tyrosinase solutions ( $B_1$ ) are not affected by roentgen irradiation up to 10 days after treatment is shown in Figure 2. Doses of from 500 to 5,000 r were given. The activity of the enzyme was determined several times during the first two days and daily thereafter to the tenth day. There was no deviation from the controls in either the activated or the non-activated tyrosinase extracts.

## 2. Effects of Roentgen Irradiation of Eggs on the Activity of the Contained Tyrosinase.

<sup>3</sup> Unpublished observations of Dr. E. E. Carothers.

—In these experiments the activity of tyrosinase in fraction *B* prepared from irradiated and control eggs was determined with and without activation with sodium oleate. Figure 3 shows that roent-

gated enzyme have been omitted to conserve space but in no case was there any activation of the tyrosinase by the roentgen rays.

### 3. Effects of Roentgen Irradiation of the

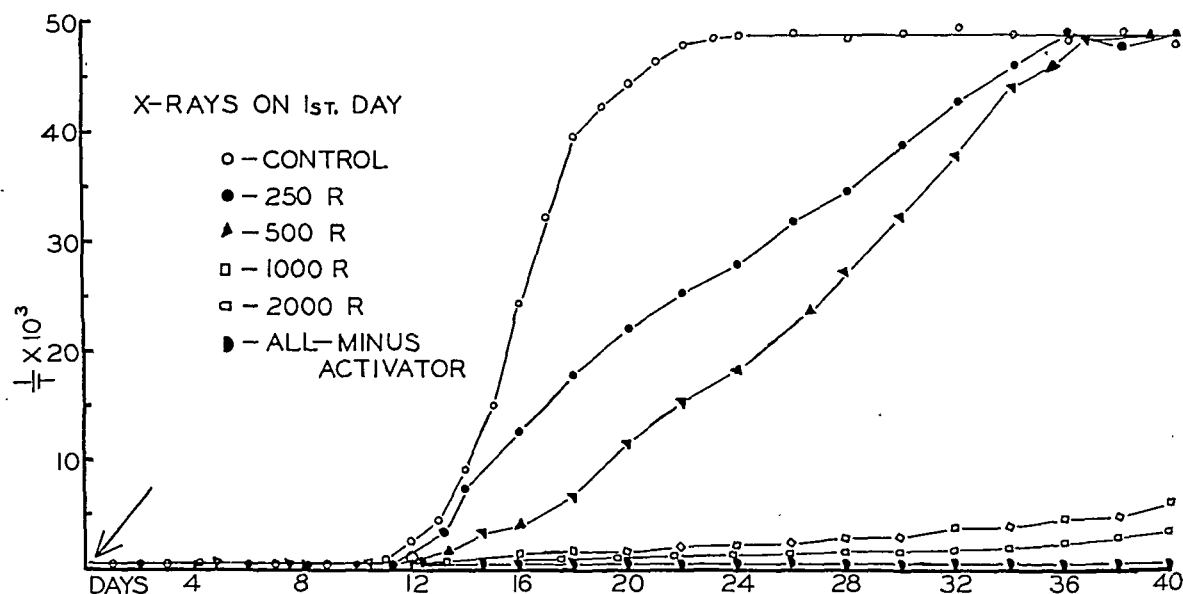


Fig. 4. Effects of roentgen irradiation of day-old eggs on the subsequent tyrosinase formation. Arrow indicates day of irradiation; ordinate, reciprocal of time for half life; abscissa, days of development at 25° C.

gen irradiation of the eggs produces no effect on the activity of the contained tyrosinase. *A* represents the effects of 10,000, 20,000, and 30,000 r on diapause eggs kept at developmental temperatures. The activity of the enzyme remains constant and equal to that of the control group. In *B* is shown the effects of 30,000 r on the tyrosinase of post-diapause eggs kept at 25° C., where they normally would contain rapidly developing embryos. The development of the irradiated embryos ceases in seven to twelve days and none of them ever hatch (controls hatch in 18–20 days) but the level of the tyrosinase activity is maintained equal to that of the controls and there seems to be no effect on the enzyme. A similar experiment is represented in *C* except that after irradiation the eggs were kept at 0° C. to prevent further development of the embryos. The results are also similar in that the tyrosinase activity is unaffected by the roentgen rays. Curves representing non-acti-

*Eggs on the Production of Tyrosinase.*—Evans (9) showed that comparatively small doses (500 r) of roentgen rays during the first few days after laying completely prevent further development of the embryo, and the question naturally arises as to the effects of such treatment on the production of tyrosinase. The results of exposing day-old eggs to 250, 500, 1,000, and 2,000 r are shown in Figure 4. The normal development of the enzyme (control curve) is seen to begin about the twelfth day and to reach completion around the eighteenth day (see Bodine, Allen, and Boell, 5). The smallest of the doses (250 r) reduces the rate of tyrosinase production to such an extent that an additional 15 days is required for the concentration of the enzyme to reach the control level. The effects of 500 r are similar but to a more marked degree: 1,000 and 2,000 r produce an inhibition of tyrosinase formation from which there is little recovery. Even 40 days after irradiation the activated enzyme responds

but slightly. The curve representing non-activated tyrosinase indicates that in no instance was there any activation by the irradiations.

In an effort to detect periods of varying

It becomes a question then as to the extent of this increasing resistance to roentgen radiation as the eggs develop. Figure 6 shows the results of experiments with larger doses of roentgen rays on the sixth

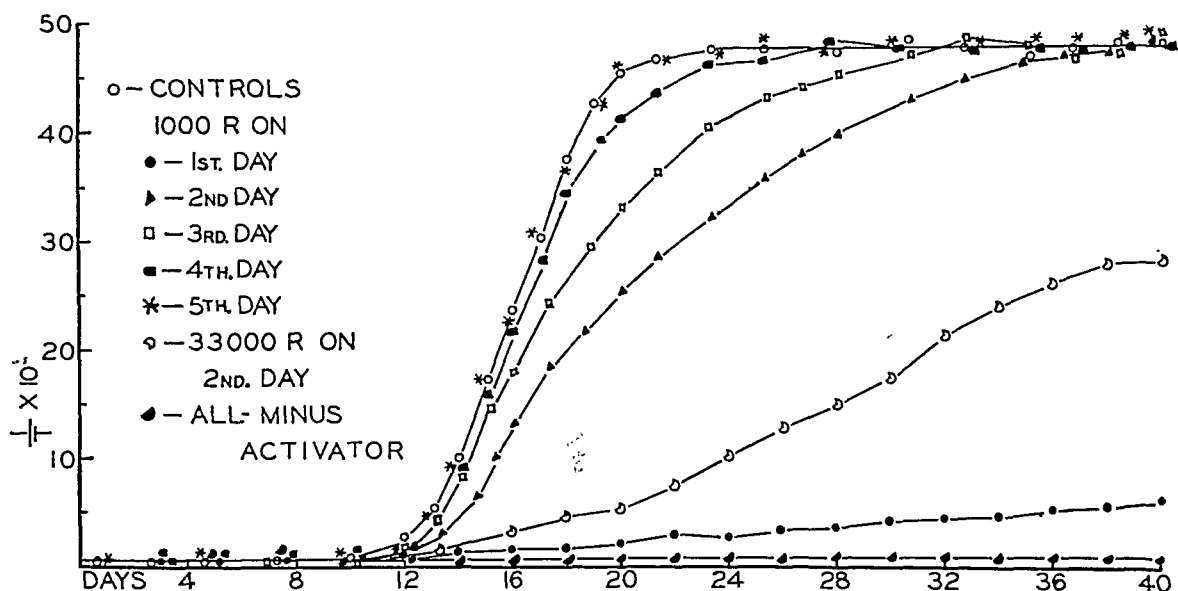


Fig. 5. Showing increasing resistance to roentgen irradiation with age of egg in respect to tyrosinase formation. Ordinate, reciprocal of time for half life; abscissa, days of development at 25° C.

susceptibility to roentgen irradiation several series of eggs were exposed to single doses of 1,000 r on the first to fifth day, inclusive, and one series was given 33,000 r on the second day. The results of this treatment are shown in Figure 5. During the first few days after laying there is a tremendous increase in resistance to roentgen irradiation as regards the subsequent formation of tyrosinase. Whereas 1,000 r on the first day almost completely prevents the production of the enzyme, the same exposure on the second day reduces the rate of formation to about 80 per cent of the control value; the control concentration, however, is finally reached. The effects of 1,000 r decrease with the age of the eggs until the fifth day, when this exposure causes no variation in tyrosinase formation from that of the control eggs: 33,000 r on the second day inhibits the development of the enzyme much less than 1,000 r on the first day. None of the exposures produced any activation of the tyrosinase.

day of development. It will be noted that of exposures to 5,000, 10,000, 20,000, and 30,000 r only the latter three cause any consistent reduction in the rate of tyrosinase formation as compared to the controls. The degree of effect retains its relative position with respect to the amount of irradiation, but in all cases the effect is slight. The beginning of tyrosinase production is retarded, but when once begun the rate of formation is almost identical with that of the controls. The attainment of maximum concentration is retarded with respect to the controls but little more than the retardation of the beginning of tyrosinase formation.

Intensive treatment with roentgen rays at a time when production of tyrosinase is occurring most rapidly had but little effect upon the rate of its production. The results of such experiments are summarized in Figure 7. It has been shown (Bodine, Allen, and Boell, 5) and confirmed (see control curves) that the tyrosinase is being

produced very rapidly from the fourteenth day to the sixteenth day. For this reason the fifteenth day was chosen for irradiation.

r of roentgen rays. Only the two larger doses produced any apparent effect, resulting in nothing more than a slight reduction

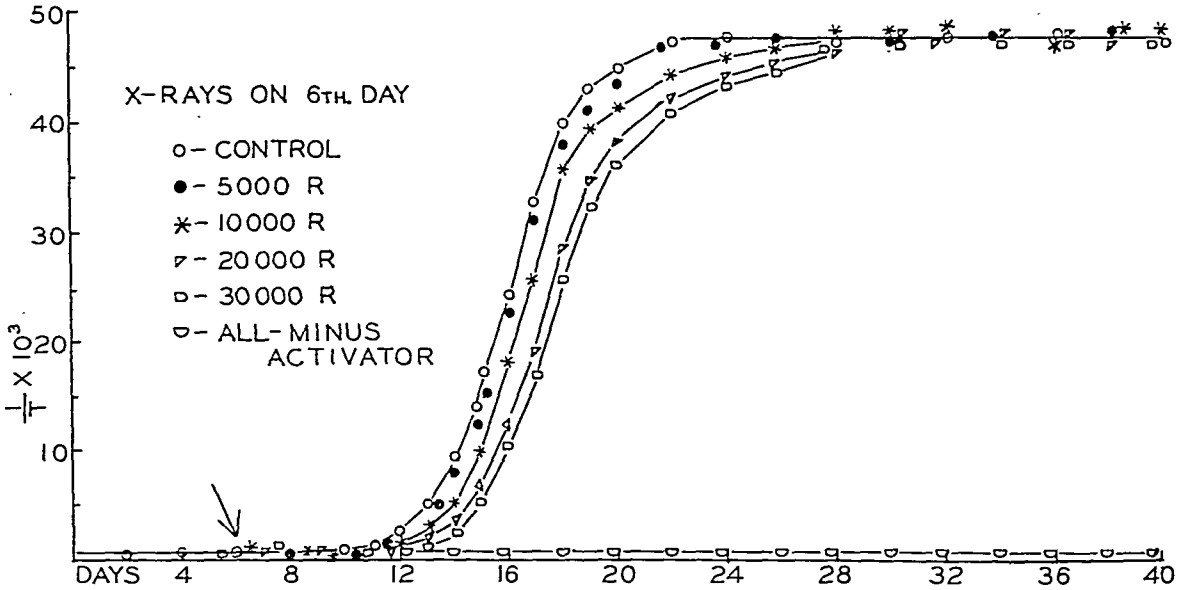


Fig. 6. Effects of intensive treatment of *M. differentialis* eggs with roentgen rays on the formation of tyrosinase beginning six days after irradiation. Arrow indicates day of treatment; ordinate, reciprocal of time for half life; abscissa, days of development at 25° C.

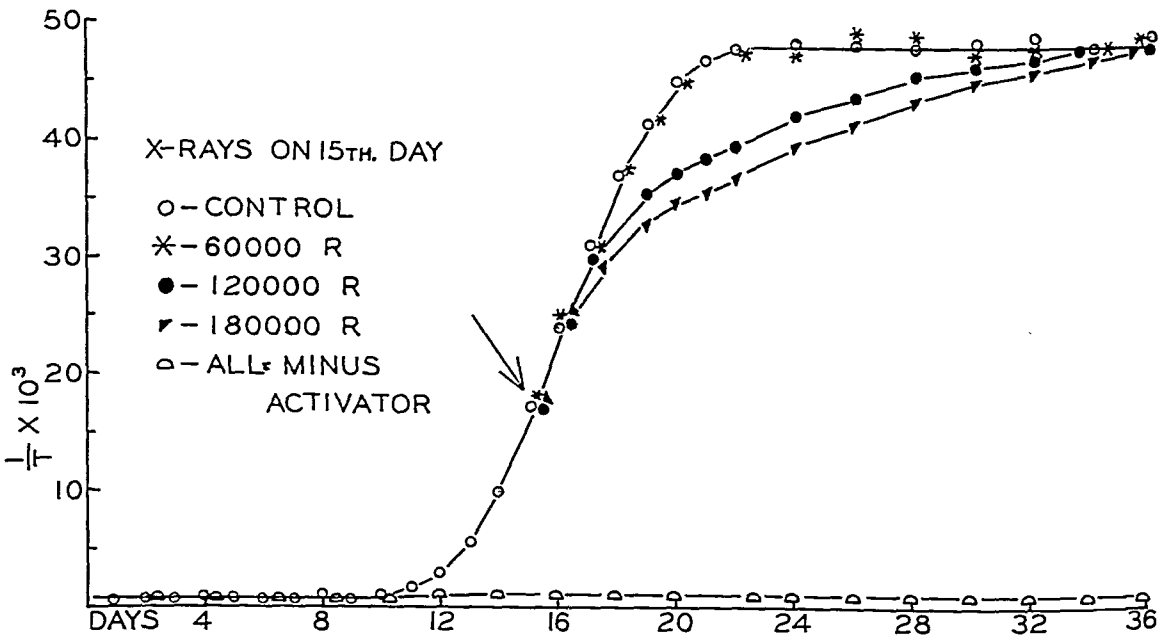


Fig. 7. Effects of large doses of roentgen rays at the time of most rapid tyrosinase production on the rate of its formation. Arrow indicates day of irradiation; ordinate, reciprocal of time for half life; abscissa, days of development at 25° C.

At this time the several series of eggs were given doses of 60,000, 120,000, and 180,000

in rate of formation of the tyrosinase (Fig. 7). The effect appears in three days

and the maximum concentration of the enzyme is attained about two weeks later than the controls. Under none of the above conditions did any activation of the tyrosinase occur.

#### DISCUSSION

Figures 1 and 2 show that exposure of tyrosinase solutions to from 500 to 5,000 r of roentgen rays does not affect the activated or the non-activated enzyme during periods from 10 minutes to 10 days after irradiation. This may seem to be in disagreement with the results of investigations on the effects of irradiation on other enzymes (Clark and Northrop, 7; Richards, 15), but it has been shown that tyrosinase is an exception to the rule in that it was not affected by the beta or gamma rays of radium (Willcock, 17). No evidence has been presented to indicate that it should be altered by roentgen irradiation.

The absence of any effect on the contained tyrosinase after extensive irradiation of developing and inactive eggs has been demonstrated (Fig. 3). Physiologically inactive eggs that presumably would be in no position to restore any destroyed enzyme were given 10,000, 20,000, and 30,000 r but with no effect (Fig. 3, A). The lack of any activation also indicated that the irradiation neither enabled the naturally occurring activator to act on the enzyme nor served in an activating capacity itself. Keeping physiologically active eggs at 0° C. after exposure to 30,000 r (Fig. 3, C) constituted an effort to simulate the inactive condition of diapause eggs. Similarly, in this case the low temperature would tend to prevent the restoration of any destroyed enzyme and the tyrosinase might also be in a more susceptible condition. However, there was no effect on the tyrosinase.

The same negative results after treatment of developing eggs with 30,000 r (Fig. 3, B) may be taken to indicate that the embryo is not essential for the maintenance of tyrosinase activity and concentration. In less than two weeks after irradiation the embryos ceased to develop

and none of them hatched. Within several weeks they died and disintegrated, during which time the tyrosinase remained unaffected.

The effects of roentgen irradiation on tyrosinase production in the egg are of considerable interest. Evans (9) has shown that the exposure of five-day eggs to 500 r results in the complete destruction of all embryos. It is rather surprising then that twice as much irradiation on the same day has no effect on tyrosinase production (Fig. 5). The exposure of older eggs to large doses of roentgen rays (Figs. 6 and 7) also results in the destruction of the embryos but has little or no effect on the subsequent formation of the enzyme. It is then apparent that tyrosinase is produced in the same amount and at the same rate after the destruction of the embryo.

The elimination of the embryo as a source of tyrosinase leaves two other possible sources, namely, the yolk cells and the serosa cells. It is known that these cells are extremely resistant to roentgen rays at times when the embryo proper is readily affected.<sup>3</sup> The enormous increase in resistance to roentgen irradiation during the first two days of development (Fig. 5) may be suggested as the key to which of these two types of cells serves as the source of enzyme. In a study of the early embryology (Slifer and King, 16) it has been shown that during the first day nearly all of the segmentation nuclei are scattered in the yolk in the process of migrating to the peripheral protoplasm, but by the second day this process is practically completed. It appears then that the increased resistance to irradiation occurs at the same time as the segmentation nuclei are taken into the peripheral protoplasm to form serosa cells. These cells are secreting the cuticle during the sixth day and hence are especially active. However, it was found that large amounts of roentgen radiation at this time did not prevent the formation of the cuticle (Fig. 6). Enormous amounts of radiation at a time when tyrosinase formation is occurring very rapidly gave similar results (Fig. 7), showing that the cells

which produce the enzyme are also strikingly resistant to irradiation even though in a state of considerable activity. This evidence does not completely eliminate the yolk cells as a source of tyrosinase, but suggests that this function is performed by the serosa cells in the orthopteran egg.

Mention may be made of a few general reactions of these cells to roentgen irradiation. It may be deduced (Fig. 4) that the segmentation nuclei which are in the process of migration during the first day are destroyed by 1,000 and 2,000 r. This is indicated by the fact that these doses completely prevent tyrosinase formation. The linear nature of the curves representing the effects of 250 and 500 r may be considered to indicate (1) that only those nuclei in the process of migration were affected, or (2) that what peripheral nuclei were affected did not recover. The nearly parallel curves in Figure 6 suggest complete recovery from the effects of those amounts of irradiation. The converse is true in Figure 7, where the attainment of control activity of tyrosinase takes place through the action of unaffected cells rather than by recovery from the irradiation. The extraordinary ability of these cells to resist the effects of roentgen irradiation is attested to in that during cuticle secretion (about the sixth day) and at the time of most rapid tyrosinase production (fifteenth day), 10,000 to 180,000 r are required to cause any measurable effects.

#### SUMMARY AND CONCLUSIONS

1. A description of the effects of roentgen rays on the enzyme, tyrosinase, and on its production in the eggs of the grasshopper, *Melanoplus differentialis*, have been presented.

2. Roentgen rays in the dosage supplied (500, 1,000, 2,000, 5,000 r) and in intervals of from 10 minutes to 10 days after irradiation produced neither inactivation nor activation of tyrosinase solutions prepared from grasshopper eggs.

3. Intensive roentgen irradiation (10,000 to 30,000 r) of diapause (inactive) eggs, of active eggs, kept at low temperature to

prevent development, and of actively developing eggs failed to have any effect on the activity or concentration of the contained tyrosinase after it has reached maximum concentration in the eggs.

4. That tyrosinase may be produced in the absence of the embryo is shown by total destruction of the embryo (1,000 r on the fifth day) without affecting the subsequent tyrosinase production.

5. There is a remarkable increase in resistance to radiation in the tyrosinase-producing cells, from the first day after laying, when exposure to 1,000 r completely prevents tyrosinase formation to a day later, when 1,000 r reduces its formation but slightly. On the second day more than 30,000 r are required to lower the enzyme concentration to 50 per cent of the control value.

6. The fact that during this time of increasing resistance the segmentation nuclei are migrating outward to combine with the peripheral protoplasm to form serosa cells suggests that these latter cells may be the source of the tyrosinase.

7. The resistance to roentgen irradiation of the tyrosinase-producing cells is so great that they tolerate dosages of 5,000 to 30,000 r five days before formation of the enzyme begins or 60,000 to 180,000 r at the time of most rapid formation of the tyrosinase.

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# VARIATIONS IN POSITION OF THE NORMAL COCCYX

By LEWIS J. FRIEDMAN, M.D., and CHARLES STEIN, M.D., *New York City*

**D**URING the routine examination of patients in the X-ray Department of Bellevue Hospital for various pathological conditions unrelated to the sacrum or coccyx, it often has been noted that the coccyx was subject to many variations in position both in the sagittal and transverse planes. This observation has been common to all roentgenologists for many years and

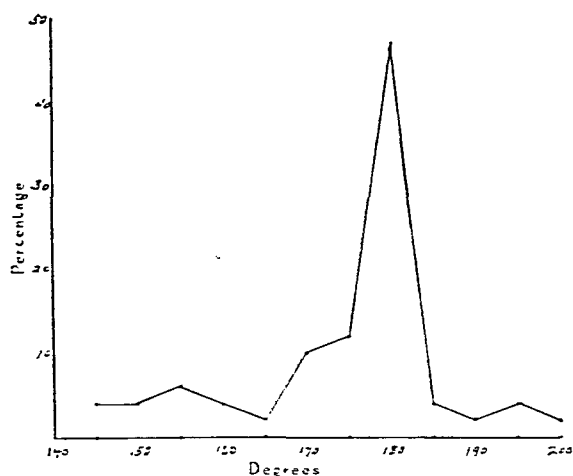


Fig. 1. Graph showing the degrees of angulation of the coccyx and the percentage of individuals with variations.

does not present any new information. However, the medico-legal aspect of such variations in position has been more troublesome. It has been the experience of many roentgenologists who were called in to testify in courts concerning the possibility of traumatism of the coccyx to hear conflicting opinions as to the significance of the various coccygeal malpositions. It was, therefore, thought advisable that a study of the normal coccyx be undertaken to show that variations in position do exist and to study their incidence and degree.

A search of the medical literature shows that the normal coccyx has not been given much space or attention. The various current textbooks on anatomy describe it as the most distal portion of the vertebral

column consisting usually of four, though occasionally three or five, rudimentary vertebrae. The texts go on to describe the configuration and structure of the various segments, but little, if any, comment is made upon the occasional anomalies of position. Previous to the advent of the x-ray, the references to the coccyx in the literature are confined primarily to discussions of trauma to the coccyx; especially posterior displacement and the treatment therefore. Various textbooks on roentgenology have commented, if somewhat briefly, on the coccyx and its relations to the sacrum. Attention has been called to the fact that merely because there is a deviation of the coccygeal segments it does not necessarily follow that it is due to trauma. H. F. Johnson has pointed out that variations in contour, length, and alignment are common. The last three or four segments are usually fused together and are frequently angulated forward at various angles. Lateral deviations are not uncommon, but are of no significance unless associated with complete luxation at the sacrococcygeal articulation.

In our study, 100 adults were chosen at random from the usual run of patients in our department with the prerequisite that they be free of any symptoms referable to the spine and that there be no history of trauma to the sacrum or coccyx. These patients were x-rayed in the anteroposterior and lateral positions. Lateral deviations were measured by drawing lines through the central planes of the sacrum and coccygeal segments and noting the angle between them. In the sagittal plane, the angulation was determined by drawing a line through the median planes of the last sacral segment, the first and second coccygeal segments, and measuring the angles between them. The angles were measured to the nearest five-degree deviation, as it was felt that this was compat-



ible with the margin of error in this particular method. In the transverse plane, 16 per cent showed a measurable amount of lateral deviation, varying from five degrees to 65 degrees. Of these, 12 cases

as being on a straight line. In this series only the cases on the extreme left side of the curve should be considered grossly as angulations, comprising only about 5 per cent of the cases. The smaller angles in

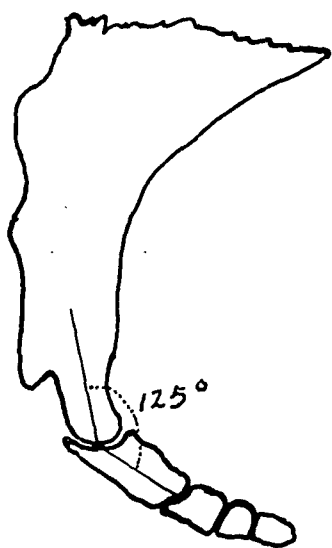


Fig. 2.

Fig. 2. Method of measuring the degree of angulation of the coccyx in relation to the sacrum, in the sagittal view.

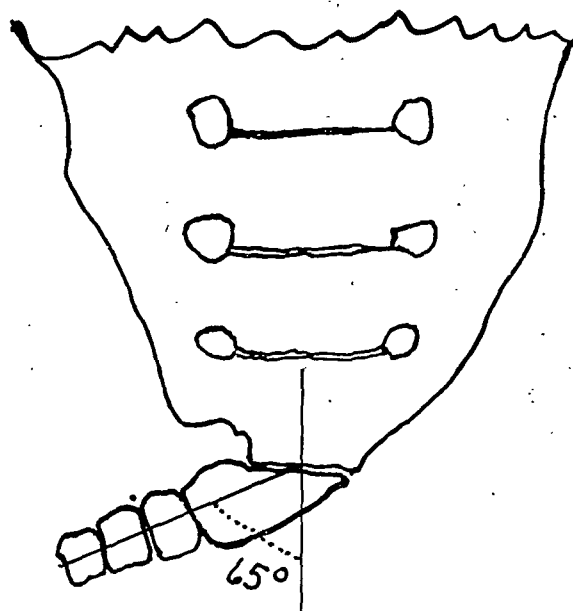


Fig. 3.

Fig. 3. Congenital anomaly of the sacrococcygeal junction. Method of measuring the degree of the lateral angulation of the coccyx in the anteroposterior view.

showed a small variation of 15 degrees or less. Of the remainder, one case showed a deviation of 65 degrees, and one of 60 degrees. There were, in addition, two cases of double angulation; that is, angulation at the sacrococcygeal articulation and also at the first intercoccygeal articulation. In one case there was a 15-degree angulation at the first articulation and one of 40 degrees at the second. In the other, there was an angulation of ten degrees at the first articulation and of 35 degrees at the second.

The data gathered from the lateral views are presented graphically in Figure 1. The deviations at the sacrococcygeal articulation correspond closely to the distribution found in the normal curve of probability. The group designated as measuring 180 degrees had the central planes either in a straight line or so close to it that for the purposes of this study they were considered

the other cases represented merely an increasingly deeper curve in the sacrum and coccyx.

The angles demonstrated between the first and second coccygeal segments closely approximated that shown for the sacrococcygeal articulation except that in none of the cases studied was there any with posterior angulation, this apparently being confined to the sacrococcygeal articulation. Due to the deepening of the sacrococcygeal curve the angles of the greatest number of cases ranged between 160 degrees and 170 degrees, with a few cases scattered between 135 degrees and 160 degrees. There were two cases showing an angle of 125 degrees and three of 130 degrees, that were considered to be angulated. In the entire series there were six cases that showed posterior angulation at the sacrococcygeal articulation and anterior angulation at the

first coccygeal articulation. There were only two cases that showed angulation in both the sagittal and transverse planes at both the sacrococcygeal and first coccygeal articulations.

### CONCLUSIONS

1. That angulations at the sacrococcygeal and first coccygeal articulations are to be found in the normal spine.
2. That the cases presenting an appreciable variation constitute only a small percentage of the total number.
3. That the variation may occur either in the transverse or sagittal plane and, more rarely in both.

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# OSSEOUS GROWTH AND DEVELOPMENT

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From the Center for Research in Child Health and Development, Harvard School of Public Health

IN the Fall of 1930 the Department of Child Hygiene, of the School of Public Health of Harvard University, in co-operation with the Boston Lying-in Hospital, and the Children's Hospital of Boston, began a study concerned with the growth and development of normal children.

Only such children were included whose mothers had been followed in the Prenatal Clinic and subsequently delivered at the Lying-in Hospital. Obviously abnormal children were excluded from the series. From the time of birth these children were examined at frequent intervals and complete records kept of various factors having a bearing on their health, growth, and development.

In addition to the careful clinical observations, roentgenograms of practically the entire body were made within 48 hours of birth. During the first year these were repeated at three-month intervals and thereafter at six-month intervals. Supplementary roentgenograms were sometimes taken between these periods.

Two hundred and twenty-eight infants have had roentgenograms at birth (112 girls and 116 boys). The decreasing smaller number of cases at subsequent age periods indicates that only a percentage of these children have yet reached any given age period. For various reasons a few of these cases have been lost or dropped, but the relative proportion of boys and girls has remained practically the same. The study is still in progress and we hope ultimately to have a composite picture of normal growth and development of this group from birth to young adult life.

All particulars will eventually be worked out in detail; correlating clinical, anthropometric, and roentgenologic data, but completion must necessarily await a good

many years. In the meantime we felt it would be worth while to present certain information already available, which is concerned with osseous growth and development.

In any attempt to evaluate the bone age from roentgenograms it is not only important to know the time at which the different osseous centers appear but also their size and contours at the different age periods. In addition to the variation consequent to age, there are fairly wide variations in normal children of the same age, commonly referred to as "normal" variations.

Tables or graphs can give only a very rough idea of these variations and for essential features there is no good method of depicting these changes except by reproductions of roentgenograms or by reproductions of accurate black and white drawings of roentgenograms. In this paper we have used drawings because they can be reduced in size to save space and can be referred to easily.<sup>1</sup>

Ideally we might have reproduced the entire skeleton but for practical purposes the bones of the hands (including wrists) and bones of the feet were in most instances adequate. This is because in these structures we find a large number of ossification centers which are constantly changing in size and contour. Furthermore, they are easy to obtain on roentgenograms and easy to reproduce on paper.

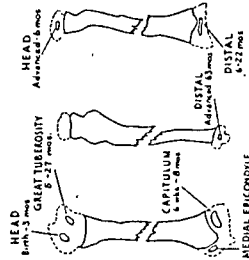
In this study an attempt was made to examine all children on the exact day listed on the charts and although this was not entirely possible, time variations were

<sup>1</sup> These reduced drawings are obviously not as accurate as original roentgenograms but serve as a practical compromise between publication space requirements and bone detail. They are intended to show features for which, after all, we have no absolute standards.

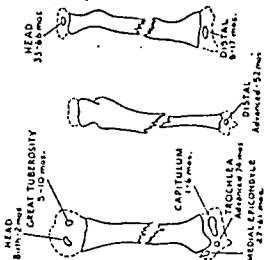
FROM  
THE CENTER FOR RESEARCH  
IN CHILD HEALTH  
AND DEVELOPMENT  
H. C. STUART, M.D., DIRECTOR  
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E. C. VOST, M.D., AND  
VERNETTE S. VICKERS

Appearance of other centers  
in upper extremity which have  
been seen between birth-  
6 1/2 years. (Range indicates  
10<sup>th</sup> and 90<sup>th</sup> percentiles)

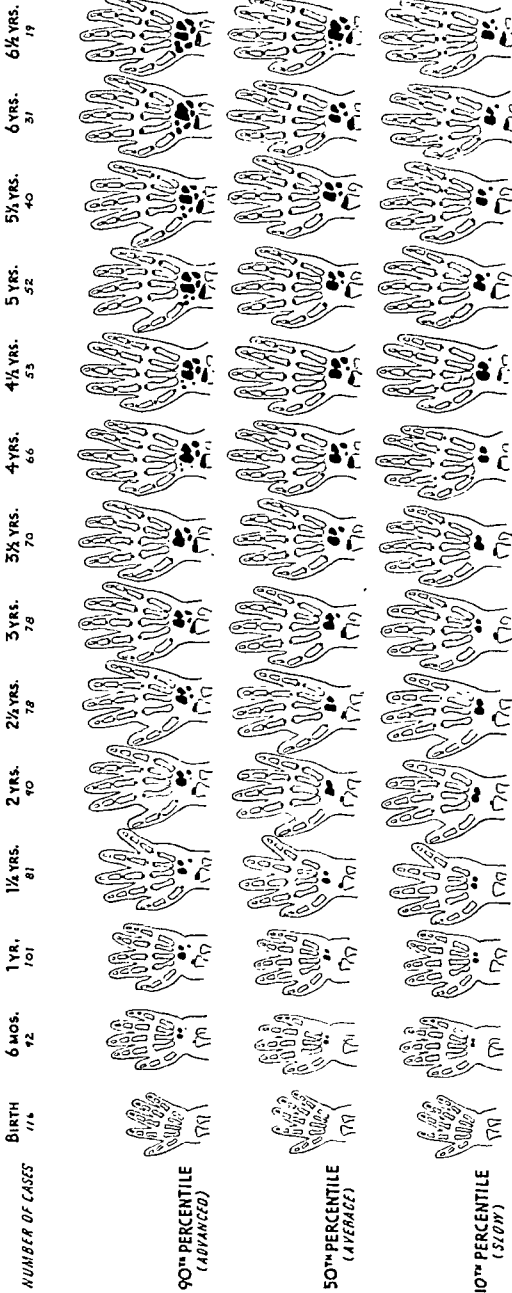
BOYS  
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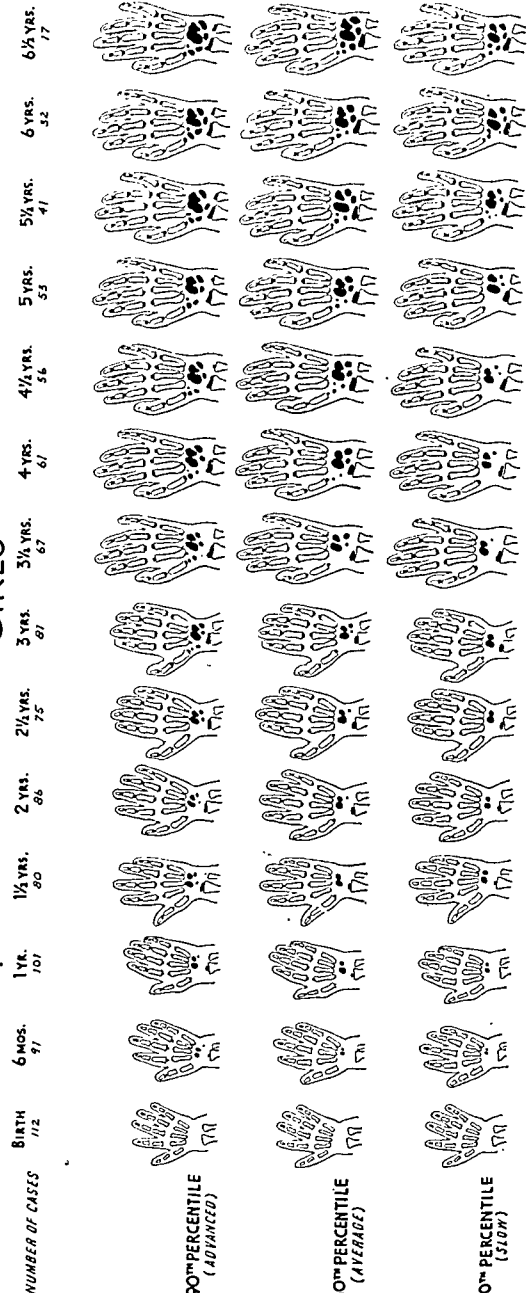
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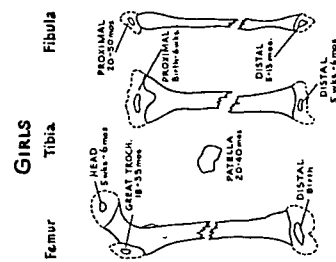
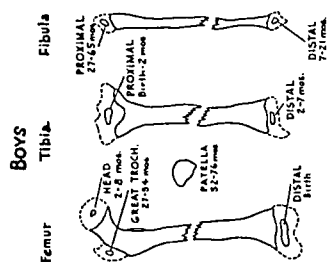


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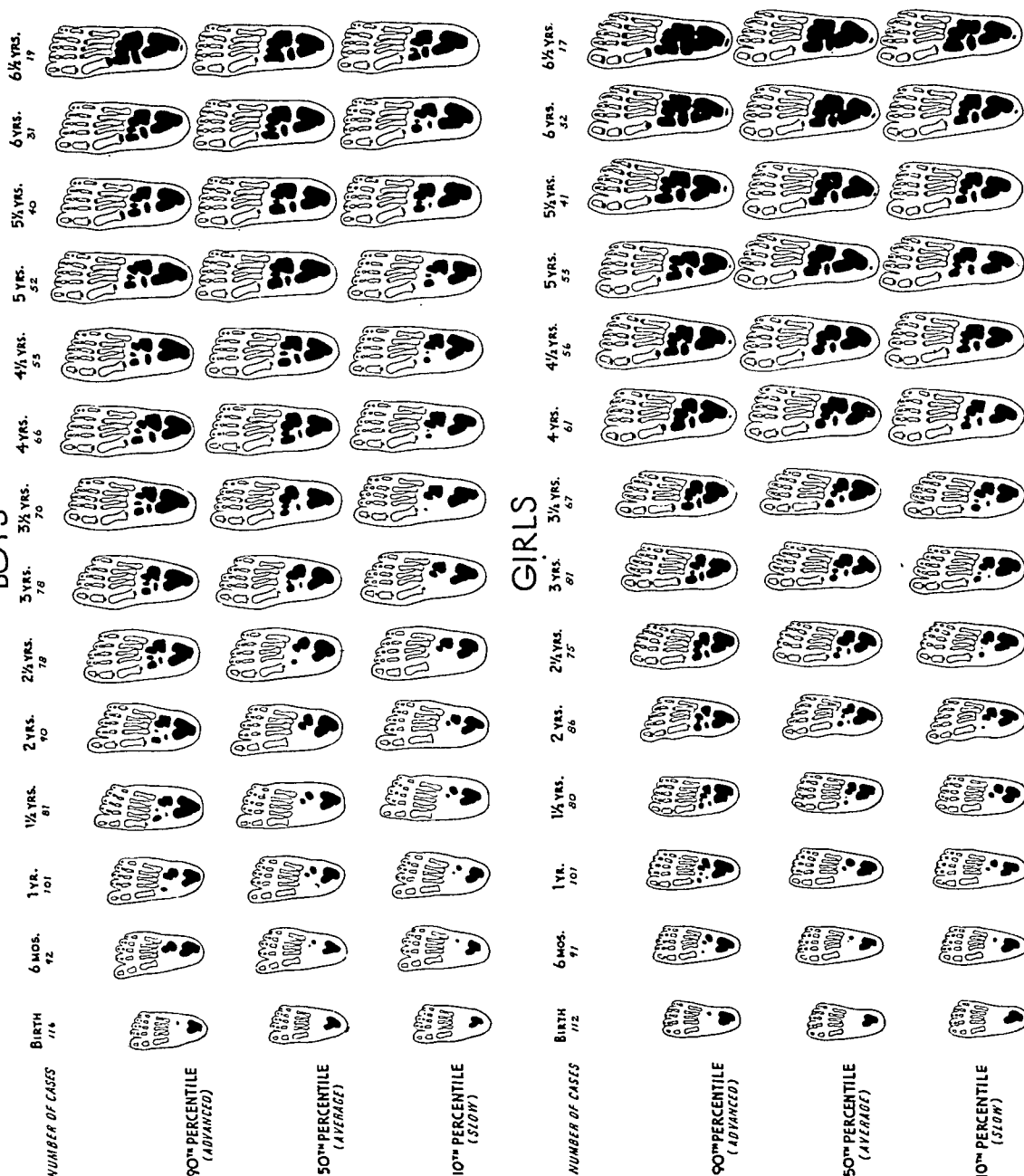
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HARVARD SCHOOL OF PUBLIC HEALTH  
E. C. VOGT, M.D., AND  
VARNETTE S. VICKERS

Appearance of other centers  
in lower extremity which have  
been seen between birth-  
6½ years. (Range indicates  
10<sup>th</sup> and 90<sup>th</sup> percentiles)



# BOYS

# GIRLS



seldom as much as plus or minus one week and never more than two weeks.

Since space does not permit listing individually all extremes of development, and since we do not feel that all extremes are desirable in a reference work of this character, we have chosen to leave out the 10 per cent of the extremes at both the upper and lower limits. This we admit is arbitrary but, if understood, we feel that it gives a good idea of the variations which may be considered well within normal limits, and leaves out those which might be considered freaks.

Only native-born whites were included in this series. No attempt was made to segregate according to ancestral nationality but with very few exceptions the parents were born in the United States, Canada, or one of the northern European countries.

In the accompanying charts average development is indicated by the middle row, or as the fiftieth percentile (half of the children have reached this stage of development). The upper and lower rows (ninetieth percentile and tenth percentile) may be said arbitrarily to represent the limits of what we choose to call "normal" variations, *i.e.*, 80 per cent of our children fall within these limits. The ninetieth percentile indicates the stage of develop-

ment which only 10 per cent of the children have reached (advanced), while the tenth percentile indicates the stage which 90 per cent have reached at any given age period (slow).

Boys and girls are listed separately and it can readily be seen that girls through this age period (birth to six and one-half years) are, in general, somewhat more advanced as far as osseous development is concerned, than are the boys.

When one compares the hands and feet of any particular child with these charts he may find that the hand age does not correspond identically with the foot age, but these variations have to be taken into consideration in arriving at the most nearly correct estimate and a certain amount of judgment has to be exercised. As previously mentioned, there is no standard osseous development and in all evaluations consideration must be given to the possibilities of ordinary or "normal" variations.

*Note.*—A full report of the studies being conducted at the Center for Research in Child Health and Development, of which these roentgenograms are a part, is soon to appear in the Monograph Series of the Society of Research in Child Development.

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# COARCTATION OF THE AORTA

THREE CASES WITH NECROPSY FINDINGS IN ONE

By TOBIAS B. WEINBERG, M.D., and CHARLES GARTENLAUB, M.D., *New York City*

From the Department of Roentgenology, Metropolitan Hospital, New York City

COARCTATION of the aorta is the term applied to the congenital stricture of the arch of the aorta, usually below the origin of the left subclavian artery. It is not an uncommon anomaly and Morgagni, in his "De Sedibus et Causis Morhorum" (1761), was the first to call attention to this condition although his case is a very doubtful one. The first authentic case with typical findings was described by a French prosector, Paris, in 1794. Meckel (1) first observed erosion of the ribs, but his illustration shows these lesions on the superior costal border, while the predominant lesions as generally reported are found on the inferior border of the posterior portion of the ribs. Railsback and Dock (2) clinically applied this information over one hundred years after Meckel reported rib erosion.

Bonnet (3), in 1903, classified the cases into the infantile and adult types as follows:

1. The *adult type* he defines as consisting of cases usually seen after infancy is passed, in which the coarctation is a more or less abrupt constriction of the aorta at or near, often a little below, the insertion of the ductus arteriosus. It is never seen in the fetus nor at birth before the closure of the ductus has begun. Skoda suggested that in this type a portion of the tissue peculiar to the ductus arteriosus extends into the adjacent aortic wall and, as the atrophy of this tissue occurs, it results in constriction or occlusion of the aorta. The process is a comparatively slow post-natal development and adequate collateral circulation has time to become established.

2. The *infantile type*, mostly seen in the new-born in which there is a diffuse narrowing, or a complete absence of the isthmus (that part of the aorta between the left subclavian artery and the junction

with the ductus Botallo). This form is commonly associated with other congenital anomalies and is not compatible with adult life. Bonnet feels that this type is developmental in origin. Blackford, in a review of 26 atypical examples of this condition in infants, believes that the adult type is also due to maldevelopment rather than to post-natal contraction of the Botallian tissue in the wall of the aorta, but he feels that the above classification, though not precise, is convenient both morphologically and clinically.

Hamilton and Abbott (5) and Blackford (4) recently analyzed all the reported cases (200), with autopsy, 12 of which had been diagnosed antemortem. They listed the following points on which a diagnosis of coarctation of the aorta may be made clinically:

1. A diminished blood pressure in the lower extremities, with retardation and diminution or complete absence of the femoral pulse, in the presence of a contrasting hypertension in the upper extremities and a full hard radial pulse.

2. The evidences of an extensive collateral circulation in the upper part of the body. It may be added that the only evidences of collateral circulation clinically may be prominent blood vessels in the neck. The symptomatology varies a great deal, Abbott (5) placing the patients in three groups:

- (A) Those in whom symptoms are absent.

- (B) Those in whom symptoms are late in developing. These symptoms are flushing of the face, profuse sweating in upper portion of the body, headaches, tinnitus, and dizziness, all of which can be associated with the hypertension in the upper extremities, head, and neck. In this group sudden rupture of the

heart, aorta, or vertebral arteries occurs.

(C) The group in which symptoms are present throughout life. These are usually the symptoms of myocardial failure which often results from secondary chronic valvular disease.

In contrast to these inconstant subjective features of coarctation of the aorta, the physical signs are diagnostic in all the cases prior to terminal complications.

Since most of the symptoms were referable to increased arterial pressure in the upper part of the body, the effect upon the activity of the thyroid gland is of interest. Ulrich (6) reported two cases in which there was an increased basal metabolic rate. He suggests that symptoms of hyperthyroidism with increased blood pressure in the young should make one alert as to the possibilities of coarctation.

Prognosis in this condition is difficult to determine for an individual case but, in general, may be based on compilations by Abbott, (7), who found the average age to be 32 years, with a range from three to 92 years. The cause of death was as follows:

Congestive heart failure	60
Sudden heart rupture	2
Rupture of aorta	38
Cerebral complications	26
Bacterial endarteritis	14

Evans (8) examined 26 cases at necropsy and the average age was approximately 11.4 years, with a slightly higher incidence in the male. Other developmental anomalies may accompany this congenital deformity of the aortic arch. The cause of death in his series was as follows:

	No.	Average Age
Heart failure	13	2.11 years
Bronchopneumonia	4	4 years
Bacteremic endocarditis	2	27.6 years
Rupture of mycotic or false aneurysm	3	26 years
Congenital stenosis of intestine	2	6 days
Pulmonary embolism	1	60 years
Foreign body in bronchus	1	1.5 years

Although most of Abbott's patients died of cardiac insufficiency, Lewis (9) points out that cases of coarctation are the best evidence that prolonged overwork of the

heart in itself does not cause myocardial failure. He observed patients in whom the heart continued to beat for as long as 16 years against a systolic pressure of 200 and a diastolic of 100. He states that only 25 per cent of the deaths in coarctation are attributable to congestive heart failure and in those cases infectious diseases or changes due to advancing age are responsible for the sudden incompetence of the heart. The important fact, as Lewis sees it, is that failure is not inevitable.

Roentgenological examination of the thorax is of the utmost importance in that the findings are pathognomonic, each being explained on an anatomico-pathologic basis. Fray (10) covers this aspect fully, dividing the evidences into:

1. Direct signs = due to atresia.
  - (a) Absence of aortic knob in postero-anterior view: not pathognomonic;
  - (b) Defect or discontinuance of the aortic arch in its descending portion in left oblique view: this is pathognomonic.
2. Indirect or secondary signs.
  - (a) Hypertrophy of the left ventricle: in 75 per cent of the cases;
  - (b) Dilatation of proximal portion of the aorta;
  - (c) Erosion of the ribs: this is pathognomonic.

This erosion of the ribs by the dilated intercostal arteries is very important and their characteristics are as follows:

- (1) Multiple; may be more than one on one rib;
- (2) Only lower margins of ribs involved;
- (3) Bilateral, usually involving the posterior portions of the ribs as far as the posterior axillary lines;
- (4) Sulcation is smoothly curvilinear, never rough or angulated.
- (5) No other alterations of the ribs;



- (6) No, or little, evidence of new bone formation: upper line may show increased density;
- (7) No pathological fracture.

#### CASE REPORTS

Three cases of coarctation of the aorta are herewith reported: two are new additions to the literature; the third case has been reported previously by Finesilver (11), but is added because of roentgenological findings not mentioned in his paper.

Case 1. A. S., a 23-year-old American-born white male entered the hospital on Feb. 11, 1935, upon advice of a physician who, treating him a month before for an upper respiratory infection, had told him that he had a high blood pressure. His family and past history are irrelevant. He denied ever having had any venereal diseases and this was subsequently confirmed by laboratory studies. He stated that he suffered from dyspnea but no orthopnea. Aside from occasional sharp precordial pains at intervals of three or four months, the patient has had no other cardiac symptoms. His dyspnea has persisted since he was 15 years of age, but has never handicapped him. He has also had occasional palpitation, but no throbbing. He coughs only when he has an upper respiratory infection.

Physical examination revealed a well developed, well nourished male, not acutely ill. The eyes, ears, nose, and throat were negative. The neck showed a marked carotid pulsation, with cervical adenopathy. There was a moderate venous engorgement of the right upper extremity. The lung-fields were clear. The heart showed enlargement to the left, 12 cm. and in the sixth intercostal space. There was a systolic blow at the apex. The aortic area showed systolic and diastolic roughening, with a split first sound. The pulmonic area showed a systolic blow transmitted to the veins of the neck. Examination of the abdomen, genitalia, and nervous system was negative. Blood pressure of the right upper extremity revealed a systolic of 150 over a diastolic of 90; the left upper



Fig. 1. Case 1.

extremity had a systolic of 100 over a diastolic of 90. The readings three days later were 170/90 and 98/90, respectively. Blood pressure readings over the lower extremities were not obtainable. The venous pressure of the right upper extremity was 6.0 cm. and over the left upper extremity was 3.5 cm. Roentgenographic examination (Fig. 1) showed an enlarged cardiac shadow with left ventricular preponderance, absence of the aortic knob, and notching of the lower borders of the right ribs posteriorly.

Case 2. E. H., an American-born 41-year-old white female, entered the hospital on Dec. 19, 1935 with a history of onset five days before of cough and pain in the right chest in its lower portion. The pains were aggravated by coughing and breathing. For three days she raised a whitish, blood-streaked sputum associated with a fever. Her family history revealed that her father had died at 70 because of a cerebral apoplexy and her mother at 72 from heart disease. Two brothers are living and well, and one sister who, she states, has heart disease. She has had measles, mumps, chicken-pox, and whooping cough. At the age of 16 she had a



Fig. 2. Case 2.

shortness of breath and pains in both legs and was then told by a physician that she had a "leaking heart." Since then she has had a dyspnea on exertion, with a swelling of the feet and ankles. In 1930 she had a pleurisy of the left chest and was hospitalized for six weeks, but required no aspiration. Her menstrual history is normal: she was married at 25. She states that her husband has had a chronic bronchitis for 20 years, coughing continually and having frequent hemoptyses. She denies any venereal infection. She has a 15-year-old child and has had three miscarriages. In 1925 she had a suspension of the uterus operation. She states that night sweats have been frequent for the past year. At the present time she weighs 102 pounds, having lost four pounds since 1934. As regards her habits, she vomits occasionally, has a poor appetite, and is at times constipated. There are no urinary disturbances.

Physical examination shows an acutely ill, malnourished adult female with a malar flush, slight cyanosis of the lips, coughing, and dyspneic. The temperature is 103, pulse 120, and the blood pressure 180 over

70. Pupils react to light and accommodation, conjunctiva pale, and the pharynx injected. The tongue is dry and coated, teeth show poor hygiene. The ears are negative and the nose shows nares patent and the septum intact. The neck shows no adenopathy, the thyroid not enlarged, and the trachea shifted slightly to the left. The thorax shows a lag of the right chest, dullness below the third rib anteriorly and D5 posteriorly. There are bronchial breath sounds anteriorly with crepitant râles. Posteriorly there are diminished bronchial-to-absent breath sounds over the right middle and lower lobes. There is a slight impairment to percussion over the left infraclavicular region. The heart is greatly enlarged to the left, right, and downward. The sounds are transmitted and heard throughout the entire chest. The aortic area shows a systolic murmur transmitted to the neck, and also a short diastolic. At the apex there is a presystolic and systolic. A double murmur is heard to the right of the sternum below the fourth rib and also a suggestion of a friction rub. The heart rate is rapid and has a gallop quality. The abdomen is soft and relaxed, the liver being felt one inch below the costal margin, and there is an old operative scar. The extremities reveal no edema, clubbing, varicosities, or deformity. The impression at this time is a right pleural effusion with an underlying consolidation of the right middle and lower lobes, a mitral and aortic stenosis and insufficiency on a rheumatic basis, and a possible pericarditis.

The next day a roentgenographic examination (Fig. 2) showed definite clouding in the lower half of the right lung-field, with increased markings above; the left lung-field was clear; the cardiac shadow was enlarged, with a left ventricular preponderance, and the ribs showed notching of their lower borders posteriorly. The conclusions were: right pleural effusion with underlying consolidation with the possibility of a pulmonary infarct and coarctation of the aorta, suggesting further study for corroborative evidence.

On Dec. 23, 1935, the patient had a

crisis and her temperature dropped to normal but two days later there were signs of a massive right basal effusion. On aspiration, 350 c.c. of a dark yellowish fluid with a ground-glass sediment was removed. At this time no femoral, popliteal, or tibial pulsations or blood pressure readings in the lower extremities were obtainable. E.K.G. studies showed the following:

Auricular rate	100 per minute
Ventricular rate	100 per minute
P-R interval	.20 sec.
Q.R.S.	.08 sec.
Deviation of electrical axis left	
	Lead 1 R slurred
	Lead 2 R slurred, S-T depressed
	Lead 3 P isoelectric, S slurred, T low

E.K.G. impression: Sinus tachycardia-myocardial damage.

The patient continued to improve and on Jan. 5, 1936, a few days before discharge, blood pressure readings showed the following:

Right arm 200/76	Left arm 194/72
Right leg 94/80	Left leg 92/76

Case 3. W. L., a 26-year-old American-born white male, truckman by occupation, was admitted on March 22, 1934. The patient was unable to co-operate or answer questions intelligently and the history was obtained from his sister. He had been normal apparently until two and one-half years before, when he suddenly developed a paralysis of the left arm followed by a complete left hemiplegia and later by a right hemiplegia. He had been in the New York Hospital on three different occasions and his condition has become progressively worse. His birth was normal, he being the last of eleven children, and he was educated through elementary school.

Physical examination showed a fairly well-developed and well-nourished male, lying quietly in bed. His manner is pleasant, with the peculiar smile of the mentally deficient. He laughs at times and his speech is restricted to a few words. There is no jaundice, dyspnea, or cyanosis, and he is incontinent. The head and neck show no deformities. The eyes show the right pupil greater than the left: both

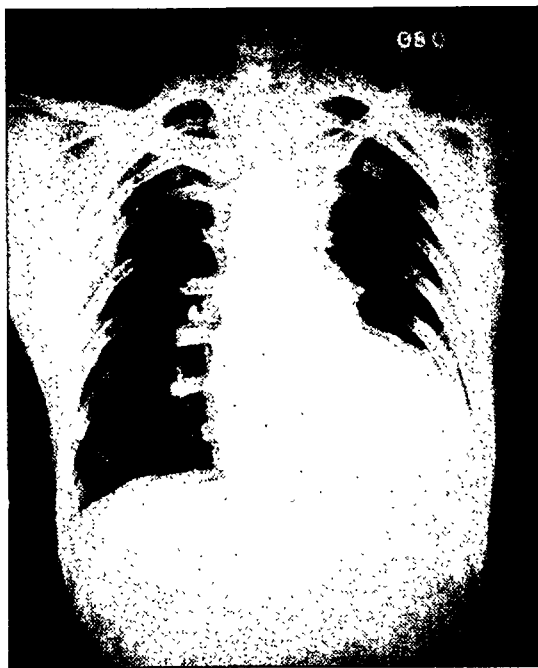


Fig. 3. Case 3.

are regular and react poorly to light. The fundi show pallor of disks with a moderate tortuosity of the vessels; no hemorrhages or exudates seen. Vision cannot be estimated due to the patient's mental status. The nose, ears, and mouth are negative. The neck shows a pulsating vessel overlying the area normally occupied by the thyroid isthmus. The trachea is in the mid-line. The thorax is symmetrical, with slight respiratory movements, and the lung-fields are clear. The heart is enlarged downward and to the left, with a harsh systolic murmur over the precordium and vessels of the neck. It is regular in rate and rhythm except for occasional systoles. The blood pressure reading in the right arm is 270/145 and in the left arm it is 260/145. No readings can be elicited in the lower extremities. The readings taken at the New York Hospital at the time of his last admission there on Aug. 26, 1933, were: right arm, 230/110; left arm, 140/100; right leg, 120/98; left leg, 105/80. The abdomen and genitalia are negative. The neurological examination reveals a bilateral optic atrophy, primary in nature, with bilateral pyramidal signs associated with

skeletal deformities such as pes cavus and hammer toe. The conclusion is a heredo-degenerative disease of the central nervous system, with cardiac abnormalities and associated hypertensive encephalopathy. Roentgenographic examination two days after admission (Fig. 3) revealed an enlarged cardia with a left ventricular preponderance, an absent aortic knob, and scalloping of the inferior margins of the ribs in their posterior portions. The patient became progressively worse and on May 7, 1935, his temperature rose to 104, respirations increased; he began coughing, and diagnosis of a bronchopneumonia was made. He failed to rally and died four days later.

The autopsy findings revealed a lobar pneumonia, subacute vegetative endocarditis, congenital anomaly of the heart (occlusion of the aortic lumen), hypertrophy and dilatation of the heart and emboli to the brain. The following is reported in detail: The pericardial sac is enlarged and occupies the entire lower portion of the left pleural cavity compressing the lower part of the lung. The fluid in the pericardial sac is normal. The heart weighs 750 gm.; epicardium is smooth. The myocardium of the left ventricle measures 2.5 cm. in thickness: the right ventricle is 0.75 cm. Section of the aortic valve shows it to be bicuspid, with a few fenestrations beneath its edge. The mouths of the coronaries show early atheromatous changes, with wrinkling of intima and a slight narrowing of the lumen. The ascending portion of the aorta appears normal. The right innominate artery is markedly dilated and shows early atheromatous changes at its site of origin. The left carotid artery is markedly dilated and enlarged. The left subclavian artery is small and atrophic in appearance. Just distal to the point of origin or the last-named vessel, the arch of the aorta is found to be completely occluded and does not allow the passage of even a small probe. The mouth of the subclavian artery is narrowed but patent.

Distal to the occlusion of the aorta, there is noted in its posterior part, the origin of the second intercostal arteries. Both arteries are dilated and show hypertrophy and enlargement, the left being greater than the right. The thoracic and abdominal aorta is atrophic, measuring one centimeter. Circulation to the left arm came from a collateral circulation established between the internal mammary and long thoracic arteries. The pulmonic valve is normal. The left auricle is dilated and hypertrophied. The edge of the mitral valve is thickened, and a large amount of hemorrhagic cauliflower-like vegetation is noted along the margin of its leaflets. The chordae tendinae and papillary muscles are hypertrophied. The tricuspid valve is normal. The myocardium is brown with irregular white fibrous patches. The foramen ovale is closed and the wall of the left ventricle bulges into the right ventricle.

We wish to thank Dr. Lynn J. Boyd, Director of Medicine, for his kind permission to report these cases.

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# THE EFFECT OF RADIATION APPLIED DIRECTLY TO THE BRAIN AND SPINAL CORD<sup>1,2</sup>

## I. EXPERIMENTAL INVESTIGATIONS ON *MACACUS RHEBUS* MONKEYS

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THE effect of radiation applied directly to the central nervous system was studied experimentally as a basis for its clinical use in children and in adults with irremovable or only partially removable tumors of the brain. It is well known that some histologic types of tumors of the central nervous system respond to radiation applied through the overlying tissues, but even in the most radiosensitive growths—such as the medulloblastomas which occur in the midline of the posterior cranial fossa in children—one cannot speak of a cure by this method of therapy. Since there are obvious advantages in the elimination of the intervening bone and soft tissues between the source of radiation and the area to be irradiated, experiments on *Macacus rhesus* monkeys were undertaken in order to gain information regarding the dangers and limitations of the application of radiation directly to the brain and spinal cord through the open wound.

The effects of varying sized doses of roentgen rays applied directly to the brain and spinal cord of these animals are here reported in their clinical and histologic aspects. The study of the results obtained by this mode of therapy, in a series of patients with tumors of the central nervous system, will form the basis for a separate report.

### LITERATURE

The literature on the effect of irradiation on the normal brain is meager. In a two-volume work on the "Biological Effects of Radiation," by Duggar, Warren was able to give a résumé of the articles on this subject, which had appeared up to 1933, in

<sup>1</sup> Supported by a grant from Child Neurology Research (Friedsam Foundation).

<sup>2</sup> Presented before Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

less than a single page. All of the experimental work was carried out in the intact animal, excepting in the case of Beier (1910) who made trephine openings in the skulls of rabbits, but closed the incision in the soft tissues before the head was exposed to radiation. Warren followed a similar procedure in experiments on dogs. Much of the work was carried out in immature animals and in many instances not only the head, but the entire animal, was irradiated.

### MATERIAL AND METHODS

Our experimental studies were carried out on adult, average-sized *Macacus rhesus* monkeys. A total of 16 animals were used, divided into three groups. In one group (eight animals), the brain was irradiated; in another group (five animals), the cerebellum and medulla oblongata, and in a third group (three animals), the spinal cord. The individual monkeys in each group received different doses of irradiation, and most of the animals were permitted to live until spontaneous death occurred. At the present time (see Table I) ten animals have succumbed and six are still alive. A histologic study of the central nervous system and other organs of the animals that died forms the basis for the present paper.

The method of procedure was the following: The monkeys were anesthetized with an intraperitoneal injection of Dial (Ciba), 0.5 c.c. per kilogram of body weight, and the part of the nervous system to be irradiated was exposed under aseptic precautions. A soft tissue flap was made in the head, the bone removed with rongeurs, and the dura was opened widely. In the experiments on the spinal cord, the dura was left intact. The adjacent bony

and soft tissues were protected against the irradiation by three layers of heavy lead rubber. In no instance was there any evidence of epilation in the protected areas.

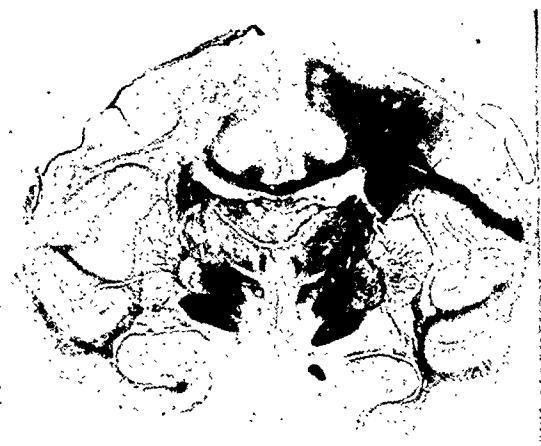


Fig. 1. Patchy demyelination of brain, chiefly on the left side. Note adherence of dura to left cerebrum. Monkey received 5,400 r to the left cerebrum and died 148 days later. Weigert's myelin sheath stain;  $\times 2.5$ .

The source of irradiation was a Westinghouse Quadrocondex constant-potential unit, in the first four animals, and a Waite and Bartlett shock-proof, oil-cooled unit for the remaining 12 animals. The physical factors employed were:

Kilovolts	200
Milliamperes	25
Target-skin distance	50 cm.
Portal	4 $\times$ 5 cm. (cerebrum and cerebellum)
	1 $\times$ 4 cm. (spinal cord)
Filtration	2 mm. Al and 0.5 mm. Cu
	r per minute = 58

The exceptions to the above mentioned factors were that in the four monkeys treated with the Quadrocondex unit, the milliamperage was eight, the r per minute, 20, and the filter 1 mm. Al and 0.5 mm. Cu. All doses were measured in air without back-scattering.

With this physical set-up, the monkeys received from 1,000 r to 5,000 r in a single dose, with the exception of three animals in which the brain was exposed twice, one week apart, and that received a total dose of 4,800, 5,400, and 7,200 r, respectively.

## THE CLINICAL EFFECTS OF IRRADIATION AND THE HISTOLOGICAL CHANGES

### 1. Radiation Applied to the Cerebrum

*Monkey No. 1.*—This animal had received 5,400 r to the left cerebrum in two doses, one week apart. Four days after the second irradiation, a mild right hemiparesis developed, which persisted. The animal remained otherwise well for 130 days, then became apathetic, paralysis of the right limbs became more marked, and death occurred on the 148th day.

*Autopsy:* The skin on the right side of the head was epilated. The brain showed a false membrane over the left cerebral hemisphere at the operative site and this was adherent to the cerebrum. The left cerebral hemisphere seemed somewhat smaller and distinctly harder than normal, especially as compared to the right side.

There was no gross change in any other organ of the body, although the mesenteric glands were enlarged. Specimens of the scalp and of the muscles and bones of the head were preserved. The left eye was removed with the optic nerve and it was preserved, together with the pituitary body, thyroid, thymus, lungs, liver, spleen, pancreas, adrenals, kidneys, testicles, stomach, and part of the duodenum.

Aside from the presence of a number of enlarged mesenteric glands probably representing a tuberculous infection, no cause of death, except for the cerebral lesion, could be discovered.

After hardening in formaldehyde, the brain was sectioned. The cortex of the left cerebral hemisphere appeared thin, and the white matter softened and granular.

*Microscopic: Left Hemisphere:* The meninges were thickened and adherent to the cortex. The hemisphere contained a large cavity surrounded by gliosis. Moreover, the walls of the cavity presented numerous fat-filled phagocytes and Nissl's plump cells. There was considerable hypertrophy of the astrocytes with fragmentation of processes and disintegration of the cells. The usual stages in the transformation of microglia to com-

pound granular corpuscles were found. There were examples of acute swelling of oligodendroglia.

changes in the nerve cells, neuroglia, microglia, and in the blood vessels which were similar to those encountered on the

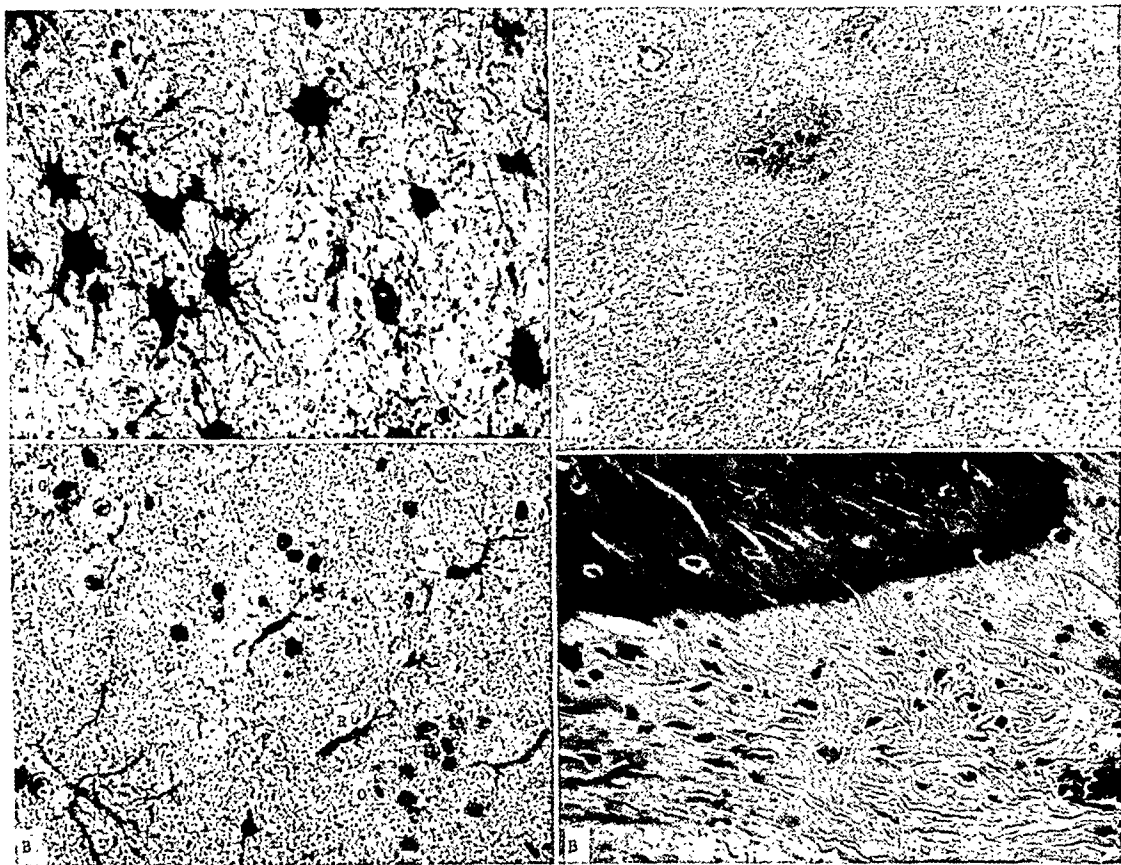


Fig. 2-A (above, left). Clasmotodendrosis (ameboid glia) of astrocytes in right cerebrum showing breaking up of expansions with formation of "filling bodies" (P). Monkey received 4,800 r to right cerebrum and died two weeks later. Cajal's gold chloride-mercuric chloride impregnation;  $\times 750$ .

Fig. 2-B (below, left). Transformation of microglia into rod cells (R) and compound granular corpuscles (G) in right cerebrum. Note acute swelling of oligodendroglia (O). Same monkey as above. Rio-Hortega's silver carbonate impregnation;  $\times 850$ .

Fig. 3-A (above, right). Hemorrhages in left cerebrum resulting from degeneration of blood vessel walls. Monkey received 7,200 r to left cerebrum and died ten days later. Hematoxylin and eosin;  $\times 160$ .

Fig. 3-B (below, right). Ossification proceeding from bony trabeculae of skull along dura mater. Note osteocytes bordering bone and dura. Monkey received 1,856 r to right cerebrum and died 322 days later. Hematoxylin and eosin;  $\times 800$ .

The nerve cells showed intense degenerative changes characterized by vacuolization of cytoplasm, eccentricity of nuclei, rupture of cytoplasmic membrane, and disintegration or shrinkage of the entire cell body. There was no neuronophagia. The normal polarity of the ganglion cells was disturbed. The blood vessels showed a slight connective tissue-thickening and in a few instances hyaline changes.

The right cerebral hemisphere showed

left side of the brain, but less marked. No cellular increase surrounded the cavitation in the right subcortical region.

Myelin sheath preparations through the coronal plane of the two hemispheres showed widespread, patchy demyelination throughout the centrum semi-ovale and internal capsule, and, to a lesser extent, in the basal ganglia, including the pons. The changes were more marked on the left side of the brain (Fig. 1).

There was an area of massive necrosis

in the liver; other organs showed no abnormality.

*Monkey No. 2.*—This animal received 4,800 r in two doses of 2,400 r, one week apart, to the right cerebral hemisphere. Two days after the second irradiation, there was weakness of the left upper extremity, and on the fourth day, there was complete left hemiplegia. The animal died three days later.

*Autopsy:* The brain was bulging moderately through the defect in the bone. There was purulent material on the external surface of the dural flap. On smears, the pus contained many cocci.

*Microscopic study:* The ganglion cells of the brain, especially of the right cerebral hemisphere, showed well defined degenerative changes varying from vacuolization of cytoplasm and dissolution of Nissl's bodies, to complete disintegration of cells. Neuronophagia did not occur. There was disruption of the normal polarity of the ganglion cells. There was diffuse hypertrophy of astrocytes with regressive changes leading to the formation of enlarged cell bodies with short fragmented processes (Fig. 2-A). Early rod cell forms occurred and there was acute swelling of oligodendroglia (Fig. 2-B). There was swelling of the endothelial cells of the blood vessels with some thickening of the vessel walls. There were no areas of cavitation, and but slight demyelination had occurred.

There were areas of necrosis in the liver affecting the interlobar zones, but no abnormality was noted in the other organs.

*Monkey No. 3* received 7,200 r in two doses of 3,600 r each, to the left cerebral hemisphere. One week after the first irradiation, the animal appeared well, excepting for slight weakness of the right upper extremity. A second dose of 3,600 r was then given. On the following day, there was complete right hemiplegia and death occurred two days later.

*Autopsy:* The flap was bulging and there was considerable pus on the surface of the bulging brain where the convolu-

tions appeared soft and necrotic. On smears, the pus contained some cocci.

*Microscopic: Left Cerebral Hemisphere:* There was marked disorganization of architecture in the gray and white matter, with cavitation and abscess formation extending into the meninges. Polymorphonuclear leukocytes, lymphocytes, and plasma cells occurred within the abscess, which lacked a limiting wall. There was no increase in the interstitial cells of the brain although hypertrophy of astrocytes with degenerative changes characteristic of clamatodendrosis occurred. Evidence of transformation of microglia to rod cells and compound granular corpuscles was seen. Few examples of acute swelling of oligodendroglia were encountered. There were marked degenerative changes in the ganglion cells characterized by pulverization and disappearance of Nissl's substance, eccentricity of nuclei, and dissolution of cell membranes. There was practically no evidence of satellitosis or neuronophagia. There was some degeneration of blood vessel walls with small hemorrhages (Fig. 3-A).

*Right Cerebral Hemisphere:* There was an increase in the perivascular and perineuronal spaces with interstitial vacuolization affecting the gray and white matter. The astrocytes had undergone slight hypertrophy. The changes in the ganglion cells were similar to, but somewhat less marked than, those in the left cerebral hemisphere.

Microscopic study of other organs showed nothing abnormal.

*Monkey No. 11.*—This animal received 1,856 r to the right cerebral hemisphere. The animal was well for 188 days when it appeared to have a left homonymous hemianopsia. On the 249th day, it had definite weakness and contractures of the left extremities. The animal died on the 322nd day after irradiation.

*Autopsy:* There were adhesions of the dura in the region of the bony defect. The entire right hemisphere was yellowish-brown in color and rather soft. The left temporal lobe was affected to a lesser degree. There was a small subarachnoid



hemorrhage on the dorsal surface of the medulla oblongata.

After hardening, the brain was sectioned. On gross inspection, there was marked dilatation of the ventricles, especially on the left side, with softening which chiefly affected the white matter of the right hemisphere. In the softened areas there were several small hemorrhages.

*Microscopic:* The *right cerebrum* presented multiple cavitation, with widespread disruption of normal architecture, involving the white matter more than the gray. The cavities contained necrotic tissue and were surrounded by gliosis. Fat-filled phagocytes and Nissl's ameboid cells were present in the wall. Astrocytes showed widespread hypertrophy with formation of monster cells, some binucleated. Degenerative changes in astrocytes were most marked in the immediate region of the cavity. There was widespread acute swelling of oligodendroglia. Transitions from microglia to rod cells and compound granular corpuscles were easily found. Fat could be seen within few of these rod cells and abundantly within the compound granular cells. The latter cells frequently surrounded blood vessels and were within the perivascular spaces. Adjacent to such areas, one could see fat within the vessel lumen. The ganglion cells showed disturbance in their normal arrangement, with degenerative changes characterized by agglomeration of Nissl's granules, shrinkage of cells, and uniform blue staining of nuclei and cytoplasm in cresyl violet preparations. The blood vessels showed slight connective tissue-thickening with hyalinization of their walls and a few small hemorrhages. The meninges were thickened, and adherent to the brain. One could see evidence of ossification proceeding from bony trabeculae along the fibrous tissue of the dura (Fig. 3-B).

The *left cerebrum* showed increase in perivascular and perineuronal spaces, with disorganization of gray and white matter and small cavitation surrounded by gliosis. Many Nissl's plump cells were seen in the vicinity of the rarefied zones, and there

was some gliosis. There was marked subependymal rarefaction with disruption of the ependymal lining. Changes in oligodendroglia, microglia and astrocytes, ganglion cells, blood vessels and meninges were similar to those occurring in the opposite cerebrum, although less marked.

No changes were found microscopically, in the other organs.

*Monkey No. 14* received 3,000 r to the right side of the cerebrum. After four and one-half months, the animal began to lose weight and to show an increasing left hemiparesis. The animal was in very poor condition one month later and was killed on the 172nd day after the irradiation.

*Autopsy:* There was a discharge of purulent material from behind the right ear which appeared to issue from a defect in the scalp and bone. The entire right petrous portion of the temporal bone appeared necrotic. Upon removal of the brain, it was found that the entire right temporal lobe had been destroyed by a necrotic process which appeared to be on the basis of an infection and which, so far as could be judged, was secondary to the destruction of the temporal bone. The remainder of the brain appeared edematous, but otherwise grossly normal.

*Microscopic Examination:* On section, there was definite demyelination of the right, and, to a slight extent, of the left, cerebral hemisphere.

*Right Cerebrum:* The meninges over the hemisphere were thickened and adherent to the brain. The brain contained a large abscess which was connected with the meninges. There were many areas of rarefaction in the white matter. There was some hypertrophy of astrocytes (Fig. 4) and clasmotodendrosis in the vicinity of the tissue destruction. Numerous pyknotic ganglion cells were present. There was moderate connective tissue-thickening of the blood vessels.

The *left cerebrum* showed well-marked degenerative changes with small cavitation. Little, if any, tissue reaction surrounded this cavity.



Fig. 4-A (above). Hypertrophy of astrocytes in right cerebrum with degenerative changes. Monkey received 3,000 r to right cerebrum, having been killed 172 days after irradiation. Cajal's gold chloride-mercuric chloride impregnation;  $\times 725$ .  
Fig. 4-B (below). Same as above;  $\times 750$ .

Microscopic study of other organs revealed no abnormality.

*Monkey No. 15* received 4,000 r to the right cerebral hemisphere. Five days later there was slight left hemiparesis which did not increase until four months later. The animal lost flesh and became weak, and died 156 days after being irradiated.

*Autopsy:* There were adhesions between dura and brain in the operative area. The right cerebral hemisphere appeared somewhat shrunken.

*Microscopic Examination:* There was thickening of the meninges over the right cerebral hemisphere. The entire brain showed an increase of the perineuronal and perivascular spaces, with vacuolization and small subcortical cavitations which were surrounded by but little increase in cells (Fig. 5-A). There was

fairly widespread dissolution of the Nissl's substance of the ganglion cells with pyknotic cells (Fig. 5-B), and but an occasional instance of neuronophagia. Hypertrophy of astrocytes with clasmatodendrosis and transformation of microglia to rod cells was noted. There was slight connective tissue-thickening of the blood vessels.

The degenerative changes in the left cerebral hemisphere and cerebellum, although well marked, were less advanced than those on the right. There were patchy areas of demyelination in the centrum ovale, chiefly on the right side.

Other organs showed no abnormality.

*Monkey No. 16.*—This animal received 5,000 r to the right side of the brain. After five days there was a left hemiparesis. The paralysis increased gradually and became complete in two months. Death occurred about four months after irradiation.

*Autopsy:* Marked edema of the right orbital tissues and of the neck and throat with ulceration in the pharynx, including the right side of the mouth and tongue, was found.

There were adhesions of the dura to the brain in the operative area. The right side of the brain appeared smaller, and was firmer in consistency, than the left.

*Microscopic Examination:* On section, there were areas of demyelination in the centrum semi-ovale, internal capsule and basal ganglia, especially on the right side. There were several large cavities in the right cerebral hemisphere which involved both gray and white matter, and were surrounded by gliosis (Fig. 5-C), the walls containing many fat-filled phagocytes and Nissl's plump cells. The ganglion cells were severely damaged, being vacuolated and staining poorly. The blood vessels had undergone moderate connective tissue-thickening with some hyaline degeneration, resulting in small hemorrhages. The changes in the left hemisphere were similar to those in the right but less marked. The cerebellum showed well-marked degenerative changes affecting many of the Purkinje cells and those of the cerebellar nuclei.

## 2. Radiation to the Cerebellum and Medulla

*Monkey No. 9.*—This animal received 4,000 r to the exposed cerebellum and remained well for about six months. Increasing cerebellar ataxia was then observed, followed by emaciation. The animal was moribund, and was killed on the 243rd day (eight months) after irradiation.

*Autopsy:* The cerebrum had a normal appearance, as did also the cerebellum excepting for meningeal adhesions. The medulla oblongata and upper cervical cord felt somewhat firm. There were no gross changes elsewhere.

*Microscopic Examination:* The cerebrum showed slight vacuolization of the white matter with some chromatolysis of ganglion cells. The cerebellum presented patchy areas of degeneration of nerve fibers in the white matter. Many of the Purkinje cells showed chromatolysis, which was more striking, however, in the brain stem. The brain stem and spinal cord were riddled with cavitations (Fig. 6-A) which were surrounded by slightly hypertrophied astrocytes. The destruction involved the white matter more than the gray, and involved equally myelin sheaths, axis cylinders, nerve and interstitial cells. There was slight connective tissue-thickening of blood vessels with few examples of proliferative changes in the cells of the endothelium and adventitia leading to narrowing of the vessel lumen. Hyaline degeneration of vessel walls occurred, in one instance resulting in hemorrhage in the pons. Vacuolization of many of the cells of the choroid plexus was present and more advanced degenerative changes in these cells were seen (Fig. 6-B).

Other organs, aside from the occurrence of pneumonia, showed no change.

*Monkey No. 10* received 5,000 r to the cerebellum and remained well for about three months. The animal then developed disturbances of equilibration, and died about one month later, with complete paralysis of the lower extremities.

*Autopsy:* The cerebrum appeared normal, and the cerebellum somewhat soft.

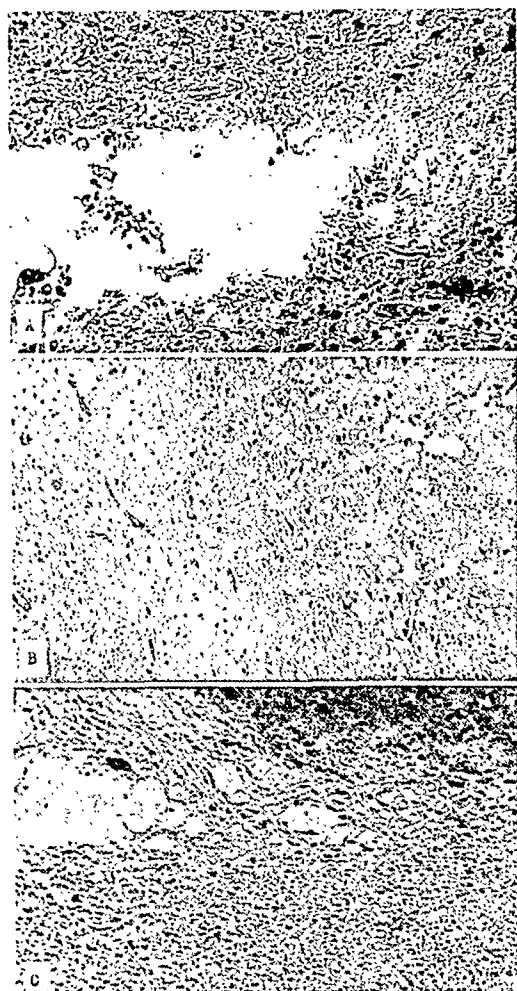


Fig. 5-A (top). Subcortical cavitation in left cerebrum surrounded by little cellular increase. Note Nissl's ameboid cells around cavity. Monkey received 4,000 r to right cerebrum and died 156 days later. Hematoxylin and eosin;  $\times 310$ .

Fig. 5-B (middle). Pyknosis of ganglion cells of right cerebrum with increase in pericellular and perivascular spaces and vacuolization—slight thickening of blood vessels. Monkey received 4,000 r to right cerebrum and died 156 days later. Hematoxylin and eosin;  $\times 150$ .

Fig. 5-C (bottom). Gliosis surrounding cavitation in right cerebrum. Monkey received 5,000 r to right cerebrum and died four months later. Hematoxylin and eosin;  $\times 160$ .

The lower part of the medulla oblongata and the upper cervical cord felt abnormally hard.

*Microscopic Examination:* The striking abnormality was the occurrence of patches of demyelination scattered throughout the white matter of cerebrum, cerebellum, pons, and spinal cord. Such changes were most marked in the brain stem and dorsal columns of the spinal cord (Fig. 7-A), in

which regions cavitation occurred. Nerve fibers remained relatively intact in some of the foci of demyelination. In the more advanced zones of disintegration, astrocyte processes appeared fragmented and cell

occurred. There was little, if any, cellular increase around the areas of destruction of brain tissue. The degenerative changes in the ganglion cells were marked. Blood vessels showed connective tissue-thicken-



Fig. 6-A (above, left). Multiple cavitation of uppermost portion of spinal cord surrounded by no cellular increase. Monkey received 4,000 r to cerebellum and was killed after 243 days. Hematoxylin and eosin;  $\times 15$ .

Fig. 6-B (below, left). Degenerative changes in choroid plexus of fourth ventricle. Monkey received 5,000 r to cerebellum and died one month later. Hematoxylin and eosin;  $\times 275$ .

Fig. 7-A (above, right). Demyelination of posterior columns of upper portion of spinal cord. Monkey received 5,000 r to cerebellum and died one month later. Weigert's myelin sheath stain;  $\times 15$ .

Fig. 7-B (below, right). Cavitation of thoracic spinal cord without cellular increase. Monkey received 5,000 r to mid-thoracic spinal cord and died three days later. Hematoxylin and eosin;  $\times 15$ .

bodies swollen; changes suggestive of clasmotodendrosis. Acute swelling of oligodendroglia was encountered and transformation of microglia into rod cells and fat-laden compound granular corpuscles

ing, which was quite marked in the brain stem. There was marked degeneration of many of the cells of the choroid plexus of the fourth ventricle. Multiple splenic necroses (probably tuberculous) occurred.

### 3. Radiation to the Spinal Cord

*Monkey No. 13* received 5,000 r to the mid-thoracic spinal cord, followed immediately by paralysis of the lower extremities. Death occurred after three days.

*Autopsy:* There was marked myelomalacia of the irradiated area.

*Microscopic Examination:* There was marked disintegration within the spinal cord with cavitation (Fig. 7-B) which involved both the gray matter and the white. Within the white matter, the myelin sheaths seemed to be more affected than the axis cylinders. There was practically no cellular reaction. Ganglion cells showed chromatolysis, and blood vessels had undergone but very slight connective tissue-thickening. The degenerative changes were most marked at the site of exposure.

Table I shows that of the 16 monkeys, ten died and six are still alive. All of the animals in which radiation was applied to the cerebrum in doses of from 1,856 to 7,200 r died. One monkey that received 1,000 r is living and well, almost two years after irradiation.

Of the five animals in which the cerebellum was irradiated, two died; one four months, and the other eight months, after the treatment. These monkeys received doses of 4,000 r and 5,000 r, respectively. Three animals (dosage 1,000, 2,400, and 3,000 r) are alive 22, 24, and 22 months, respectively, after irradiation.

In three animals the radiation was applied to the mid-thoracic spinal cord. One monkey (dosage 5,000 r) died after three days; the others are alive—one still well after about seven months (1,000 r), the other has had a paraplegia for 12 months, but is living at the present time, 20 months after receiving 4,000 r.

Of the ten animals that died, two (Nos. 2 and 3) died after from three to five days, from a wound infection, but both of these animals (dosage 4,800 r and 7,200 r) had a hemiparesis immediately after irradiation. In a third animal (No. 10), that received 5,000 r to the cerebellum

and that lived for 121 days, death may have been due in part to visceral tuberculosis. In seven animals, death was due directly to the irradiation. Five of these died in 135 to 322 days (four and one-half to 11 months) after irradiation of the cerebrum, one 243 days (eight months) after irradiation of the cerebellum, and one three days after the spinal cord had been irradiated (dosage 5,000 r).

The main clinical symptoms presented by the animals in which a cerebral hemisphere was exposed to the roentgen rays, consisted of hemiparesis, which usually increased up to death. The animals in which the cerebellum was irradiated, developed ataxia after from three to five months, and one in which the spinal cord was exposed to the x-rays had a paraplegia immediately after irradiation.

Grossly, the predominant changes in the nervous system consisted of atrophy or softening of the irradiated hemisphere with adhesions between the brain and meninges. In two animals, there were ulcerative processes in the soft or bony tissue of the head or neck. In the animal in which the spinal cord was irradiated, there was a marked myelomalacia.

Microscopically, the effect of roentgen radiation proved to be primarily upon the parenchyma of the brain, rather than upon the blood vessels. Connective tissue-thickening of blood vessels did occur, but it was not sufficiently marked to account for the severe parenchymatous degeneration. In four cases, degeneration of the walls of blood vessels, with hemorrhage, occurred.

Chromatolysis of ganglion cells leading in some instances to complete disintegration without satellitosis or neuronophagia occurred. There was hypertrophy of astrocytes, frequently with gliosis around cavitation. Degeneration of astrocytes forming the ameboid glia of Alzheimer or the changes seen in clasmatodendrosis of Cajal occurred. There were numerous examples of fragmentation and disappearance of processes of oligodendroglia with distention of cell body by clear fluid,

TABLE I.—SUMMARY OF CLINICAL AND ANATOMICAL EFFECTS OF RADIATION TO THE CENTRAL NERVOUS SYSTEM IN *MACACUS RHESUS* MONKEYS  
(Up to April 1, 1938)

Monkey No.	r	Immediate Effects		Later Effects	Outcome		Histologic Changes at Necropsy
					Still Living	Died	
Cerebrum							
1 Left side	1,800* } 3,600 }	Hemiparesis (right)	Increased paralysis after 4 mos.	.....	After 148 da.	(1) Cavitation of cerebral hemispheres surrounded by gliosis. (2) Widespread chromatolysis. (3) Disturbance in polarity of nerve cells in cortical laminae. (4) Increase in pericellular and perivascular spaces with vacuolization of white matter. (5) Scattered demyelination. (6) Degenerative changes in neuroglia and ependyma. (7) Formation of compound granular cells. (8) Slight connective tissue thickening of blood vessels with some hyalinization of walls.	
2 Right side	2,400* } 2,400 }	Hemiparesis (left)	Infected wound	.....	After 14 da.	Changes similar to those in Monkey No. 1 without cavitation and otherwise much less marked.	
3 Left side	3,600* } 3,600 }	Hemiparesis (right)	Infected wound	.....	After 10 da.	Intense degenerative changes as in Monkey No. 1 with (1) Abscess formation; (2) Degeneration of blood vessel walls resulting in small hemorrhages, and (3) Chromatolysis of ganglion cells of opposite cerebral hemisphere, more marked than in Monkey No. 1.	
7 Left side	1,000	None	None	Well 1 yr. 311 da.	.....		
11 Right side	1,856	None	Left hemianopia and left hemiparesis after 6 mos.	.....	After 322 da.	Changes similar to those in Monkey No. 1 although (1) Degenerative changes were less marked, and (2) Small hemorrhages resulted from hyaline degeneration of blood vessels.	
14 Right side	3,000	None	Increasing left hemiparesis after 4 1/2 mos.	.....	After 172 da.	Changes similar to those in Monkey No. 1 although (1) Abscess formation had occurred, and (2) No cellular increase surrounded cavitation in hemisphere opposite to the exposed one.	
15 Right side	4,000	Slight hemiparesis (left)	Progressive debility and paralysis after 4 mos.	.....	After 156 da.	Changes similar to those in Monkey No. 1 although (1) Degenerative changes were less marked, and (2) Very little cellular increase surrounded cavitation.	
16 Right side	5,000	Hemiparesis (left)	Paralysis complete after 2 mos.	.....	After 135 da.	Intense degenerative changes as in monkey No. 1 with (1) Small hemorrhages resulting from hyaline degeneration of blood vessels.	

Cerebellum and Medulla				
	None	None	Well 2 yr. 15 da.	
4	2,400	None	Well 2 yr. 15 da.	.....
6	1,000	None	1 yr. 311 da. Weakness both lower extremi- ties for about 1 yr.	.....
8	3,000	None	None	
9	4,000	None	Well 1 yr. 294 da.	.....
		Cerebellar ataxia after 5 mos.	.....	
10	5,000	None	.....	After 243 da.
		Cerebellar ataxia after 3 mos.	.....	
5	1,000	None	Spinal Cord (Mid-thoracic)	
12	4,000	None	Well 205 da.	.....
13	5,000	Paraplegia	1 yr. 261 da. Paraplegia low- er extremities for 1 yr.	.....
		Rapid deteriora- tion	.....	
			After 3 da.	
				(1) Multiple cavitations. (2) No cellular increase around cavitation. (3) Myelin sheaths more affected than axis cylinders in de- (4) Chromatolysis.
				Above changes in all cases were most intense at site of exposure to x-rays.

Changes similar to those in Monkey No. 1 except that  
(1) Cavitation involved brain stem and upper portion of  
spinal cord;  
(2) No cellular increase surrounded cavitation;  
(3) Proliferative changes of endothelial and adventitial cells  
occurred;  
(4) Small hemorrhages in pons resulted from hyaline degen-  
eration of blood vessels, and  
(5) Degenerative changes in cells of the choroid plexus oc-  
curred.

Changes similar to those in Monkey No. 9 except that  
(1) Proliferative changes of blood vessels did not occur;  
(2) Hemorrhages were not present;  
(3) Chromatolysis of cells of brain stem was more marked, and  
(4) Degenerative changes of choroid plexus were more marked.

\* The first three animals received divided doses one week apart.

characteristic of the acute swelling of oligodendroglia described by Penfield and Cone. Swelling of microglia, with fragmentation of cell processes forming rod cells, occurred. These changes in nerve cells, astrocytes, oligodendroglia, and microglia were concomitant findings. Adjacent to areas of necrosis of tissue, various stages in the transition from microglia and rod cells to fat-laden compound granular corpuscles (*Gitterzellen*), which frequently filled the perivascular spaces, were found. Scharlach R preparations revealed fat within the lumen of the blood vessel in some instances, with rod cells and microglia a short distance from the vessel wall, suggesting transfer of the phagocytized material into the vessel with resumption of the normal microglia form as suggested by Penfield (1925). All of the material showed an increase in perivascular and perineuronal spaces, with interstitial vacuolization affecting the white matter more than the gray. Frequently, patchy areas of demyelination, which were not necessarily in relation to blood vessels, were found.

A later stage in degeneration seemed to be represented by cavitation which, in the cerebrum, was usually surrounded by gliosis and involved the white matter more than the gray. Numerous fat-filled phagocytes and Nissl's plump cells often occupied the walls of these cavities.

It is of interest that little or no evidence of satellitosis and neuronophagia followed ganglion cell degeneration. This fact, together with the usual absence of gliosis around cavitations in the brain stem or spinal cord, is rather suggestive of a damaging effect of irradiation upon the ability of neuroglia to react in its usual manner. However, gliosis did occur in many instances around cavitations within the cerebrum, the intensity of the gliosis appearing to vary directly with the dosage of x-ray and, probably to a greater extent, with the survival period of the animal.

#### SUMMARY

The effects of large single doses of roent-

gen rays, directly upon the brain and spinal cord of monkeys, were very marked, and the rapidity with which the clinical symptoms occurred was proportional to the dosage. A dose of 4,000 r or more to a cerebral hemisphere was followed almost immediately by a more or less well-marked paralysis of the contralateral limbs. After a dosage of approximately 2,000 to 3,000 r, the animals developed a hemiparesis after several months.

None of the animals in which the cerebellum was irradiated, developed any immediate symptoms, but in two of them (dosage 4,000 r and 5,000 r) cerebellar disturbances appeared after from three to five months.

Of the three animals in which the mid-thoracic spinal cord was exposed to the radiation, one developed immediate paraplegia (dosage 5,000 r), and another (dosage 4,000 r) developed a paraplegia after five and one-half months.

These results indicate that the small brain of the *Macacus rhesus* monkey will tolerate massive single doses of x-ray applied directly through the open wound in doses of less than approximately 2,000 r to the cerebrum, and less than 4,000 r to the cerebellum and spinal cord, without causing death of the animal. However, the monkeys that are still alive after about two years, may in the future succumb to the effects of irradiation. It is of particular interest that the disabilities these monkeys presented frequently came on as a late effect following irradiation, and that they were progressive.

In all the animals which died, there were well-marked changes in the central nervous system. When one cerebral hemisphere was irradiated, both the homolateral and the contralateral hemispheres were involved—the latter much less than the former. The changes in the cerebellum following irradiation to this region were similar to those in the cerebrum and lesions were found also in the medulla and cervical spinal cord. When large doses of radiation were applied to the cerebrum, chromatolysis of ganglion cells of the cerebellum



occurred; similarly when the cerebellum was thus irradiated, degeneration of ganglion cells of the cerebrum was found. The effects of massive doses of roentgen rays were especially marked in the glia and nerve tissues, and, surprising as it may seem, the changes in the blood vessels were slight in degree. The irradiation produced mainly a parenchymatous degeneration, both nerve and glia cells being profoundly affected, the axis cylinders sometimes appearing to be less severely involved than the myelin sheaths.

The two factors which seemed to play a part in governing the intensity of the histological changes were the dosage of x-ray and, to a less extent, the time interval between irradiation and autopsy. It seemed, both on clinical and histological grounds, that the destructive changes were to some extent progressive, although the period of time during which such progressive changes may occur has not been determined.

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# CHARACTERISTICS OF X-RAYS

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## A. *Production of X-rays*

1. X-ray tube: An envelope of glass containing a filament, target, and an extremely high vacuum.

### (a) Target

(1) High melting point—in order to withstand higher temperatures—hence a higher capacity in production of x-rays.

(2) High atomic weight—to secure a better output of radiation, or characteristic x-rays of a better quality.

(3) Low vapor pressure—to keep volatilization at a minimum, so as to avoid metallic deposit on the walls of the x-ray tube.

(4) Good conductor of heat—enhanced by embedding a target in a copper sleeve and also by cooling same with air, water, and oil.

2. Change of kinetic energy of electrons to radiant energy depends upon:

### (a) Attraction of electrons to the target

(1) Electrons carry a negative charge—hence the target must carry a positive charge compared to the electron because mutual attraction between unlike charges causes the electron to move to the target.

(2) As the difference in charge or potential increases, more energy will be imparted to the electron emerging from the filament of the x-ray tube.

(3) The electron is suddenly

stopped at the face of the target and about one-half of 1 per cent of the kinetic energy goes into x-rays, while about 99.5 per cent goes into heat.

(4) In the sudden stopping of the fast moving electron, *general x-rays* are produced—since the electron has its own magnetic field, the magnetic field tends to go on, or is bent when the electron is suddenly stopped, with the result that an electromagnetic wave of radiant energy emerges from the target.

(5) Characteristic x-rays: When the electrons from the filament of the x-ray tube attain sufficient speed, the atomic structure of the target atoms are penetrated.

(a) When the filament electron enters the atomic structure, some of the atomic structure, some of the atomic orbital electrons are displaced. As the position or energy level of the displaced orbital electrons is reoccupied by another electron, the energy required to displace the electron is returned in the form of radiant energy.

(b) As the atomic weight of the target is increased, a higher voltage is required to give the filament electrons sufficient

energy to enter the more complicated atomic structure.

characteristic radiation superimposed on general x-rays.

(c) This radiant energy is called "characteristic" or "fluorescent" because it is characteristic in wave lengths for any particular emitter.

(d) Characteristic x-rays are classified as K, L, M, N, etc., depending upon whether an electron is displaced from the innermost electronic orbit known as K, or outer orbits known as L, M, etc. Hence the shortest band of wave lengths arises because an electron is displaced from the K orbit, a band of longer wave lengths from L orbit, etc.

(6) General x-rays, therefore, comprise a heterogeneous group of wave lengths running from the longest wave length capable of penetrating the glass bowl of the x-ray tube and the shortest wave length, which is a function of the maximum or peak voltage applied to the target.

(7) Characteristic x-rays comprise a series of more or less homogeneous bands of x-ray wave lengths arising from the K electronic orbit of the atom, and another more homogeneous band arising from the L electronic orbit, etc. The different bands of characteristic wave lengths occupy definite positions in the x-ray spectrum depending upon the atomic weight of the x-ray target.

(8) The x-ray spectrum represents a composite picture of

#### B. *Properties of X-rays*

1. X-rays are invisible and transmitted through space in a similar manner to light.
2. Travel in straight lines.
3. Can be reflected and refracted from crystals.
4. Speed of light and x-rays is 186,000 miles per second.
5. Produced by impact of electrons on matter.
6. Ionizes gases.
7. Produces fluorescence and phosphorescence.
8. Produces chemical changes.
9. Biological changes in tissue by the process of ionization of the cell, causing a chemical change followed by biological changes.

C. *X-ray Spectrum*: A heterogeneous beam of x-ray wave lengths can be separated or diffracted by passing a narrow beam of x-rays through a rock salt or calcite crystal. According to the angle at which the primary beam enters the crystal, different wave lengths can be diffracted into an ionization chamber or onto a photographic film.

1. The regular arrangement of atoms in rock salt and calcite crystals diffract the x-ray wave lengths, giving the same results as are obtained by a line grating in diffracting light rays.
2. If an ionization chamber is used to measure the intensity of different wave lengths, a curve can be plotted to represent the x-ray spectrum with wave lengths in Ångstrom units as abscissa and corresponding intensities as ordinate (one Ångstrom unit equals  $1.0 \times 10^{-8}$  cm., or 0.000.-000.01 cm.).
3. The maximum wave length is the longest wave length that can penetrate the glass of the x-ray tube.
4. The minimum wave length is the shortest wave length that is pro-

duced by a given peak voltage.

Formula—

Minimum wave length in Ångstrom

$$\text{units} = \frac{12,354}{\text{peak voltage}}$$

#### D. *The Factors Governing the Quality of X-rays*

1. Target material: The characteristic x-ray wave lengths vary with the atomic weight. General x-ray wave lengths are the same for any material.
2. Voltage: The minimum wave length decreases as the voltage increases.
3. Filter: A filter removes a percentage of all wave lengths, the percentage of the minimum wave length being least and the percentage gradually increasing until a 100 per cent is absorbed. The quality of a filtered beam of x-rays is more homogeneous in short wave lengths.

#### E. *The Factors Governing the Quantity of X-rays as Measured in Air*

1. The voltage: As the voltage is increased, a greater number of all wave lengths is produced, therefore increasing the intensity. The filament electrons are not stopped at the first impact, but as they penetrate into the target, x-rays of different wave lengths are produced until the electron is totally absorbed.
2. Milliamperage: As more electrons are produced by an increase in filament current, a greater milliamperage results with an increase in intensity.
3. Filter: Since the filter absorbs radiation passing through, the intensity is altered.
4. Distance: The intensity varies approximately as the inverse square of the distance from the target. With the oil-immersed x-ray tubes, the inverse square law cannot be applied when measuring the intensity for very short skin-target distances, due to the scattering of x-rays in the oil.

#### F. *The Action of Filters*

1. A very large percentage of the absorption of x-rays by low atomic weight substances is due to scattering of the radiation. The loss of energy by scattering results in lengthening of the wave lengths. Low atomic weight substances as aluminum, carbon, etc., are not good filters for high voltage radiation.
2. Higher atomic weight filters function in two ways in changing the beam of radiation; by the process of scattering, and by the production of characteristic or fluorescent radiation in the filter. Since the production of characteristic radiation is a function of the atomic weight, the x-ray spectrum of filtered radiation indicates that for 200 kv. radiation, copper and a composite filter of tin, copper and aluminum give the best resultant beam.
3. Copper is usually used for high voltage (200 kv.) radiation. A composite filter of 0.4 mm. tin + 0.2 mm. copper and 0.5 mm. aluminum is often substituted for 2.0 mm. copper + 0.5 mm. aluminum. The composite filter gives approximately the same quality of radiation as 2.0 mm. Cu, but allows from 15 to 20 per cent more radiation to pass through. A composite filter of lead + tin + copper + aluminum is often used for supervoltage therapy. The sequence of the different elements with varying atomic weights are necessary to remove characteristic radiation of the preceding filter. The aluminum is placed between the copper filter and the patient to remove the soft characteristic radiation from copper, and for the same reason, the copper is placed beneath the tin and the aluminum next to the patient.

#### G. *The Theory of Radiant Energy*

1. The electromagnetic wave theory of x-rays was verified following the prediction of Professor Laue, in 1912.

that the regular arrangement of atoms in crystals as rock salt and calcite should diffract x-rays as light wave lengths are diffracted by a ruled grating. Friedrich and Knipping experimentally obtained an x-ray spectrum.

2. Following the discovery by Compton that a large percentage of scattered x-rays leave the scattering medium with a longer wave length than the primary beam, other experimental evidence made it difficult to explain all the facts by the electromagnetic continuous wave theory. If the electromagnetic wave can be visualized as being made up of units or chunks of energy called quanta, it would be possible to explain the discrepancies between experimental findings and the electromagnetic wave theory.

#### H. *Scattering of X-rays*

1. X-rays scatter very much as light scatters in a fog. The absorption of x-rays is almost entirely due to scattering in low atomic weight substances.
2. Quanta of x-ray energy is  $h\nu$ ,  $h$  being Planck's constant  $6.55 \times 10^{-27}$  erg seconds and  $\nu$  the frequency. The frequency ( $\nu$ ) times the wave length ( $\lambda$ ) equals the speed of x-rays or light ( $c$ ). It is readily seen that the quantum of energy of short wave length radiation has a higher frequency and a higher energy quantum than one of long wave length and low frequency.
3. As a quantum of energy strikes an atom, a recoil electron is ejected, and at the same time the quantum is deflected or scattered with a loss of energy. As Planck's constant cannot change, the frequency  $\nu$  is reduced, with a resultant longer wave length, since the product of frequency and wave length equals the speed of x-rays, a constant.
4. The same quantum continues to scatter, the frequency being gradu-

ally reduced and corresponding wave length increased, until the quantum either emerges from the filter or comes in contact with an atom in such a manner as to be totally absorbed, at which time a photo-electron is ejected. The photo-electron leaves the atom with considerably more energy than the recoil electron. The photo-electron will travel farther in the tissue and produce more secondary ionization than the recoil electron.

5. The energy that a quantum loses in scattering is a function of the scattering angle. A quantum scattered back on itself will lose the maximum energy, a quantum scattered at right-angles will lose less energy, and a quantum can strike an atom and not give up any energy. If this happens, the wave length remains unchanged.

#### I. *Ionization:* The production of ions in a gas by x-rays, neutrons, radium rays, etc., which renders the gas conductive only while the source is present or active.

1. Since the composition of all atoms is an aggregation of electrical charges with a positive nucleus surrounded by sufficient number of electrons in motion to counteract the excess positive charge on the nucleus, the result is that all evidence of a charge is neutralized. X-rays, neutrons, radium rays, and other forces passing through a gas remove one or more electrons from a gas atom. This leaves the atom positively charged. These charges can be collected and the rate of ionization evaluated.
2. Because the conductivity of the gas continues only while x-rays are present, it is possible to measure the intensity of x-rays by measuring the conductivity of the gas which is a function of the rate of producing ions in the air.
3. The rate of ionization will change with the concentration of the number of atoms in a given volume of

gas, since all of the atoms in the path of the x-rays are not ionized. The concentration of atoms in a volume of gas will vary with the pressure and temperature, which means a variation in the conductivity of the gas.

J. *Measurement of the Quantity of X-rays in Roentgens*

1. Photographic Method: The rate of blackening of a photographic film is not the same when the wave lengths change; the same holds true for penetrometers or wedges of different filter thickness.
2. Chemical Method: Change in the color of certain dyes, as methylene blue—not in general use. Also the change in resistance of a selenium cell: the selenium cell becomes fatigued under action of x-rays which renders it inaccurate.
3. Fluorescence Method: Certain crystals fluoresce under the influence of x-rays, but there is no accurate method gauging the changes in fluorescence.
4. Biological Method: Erythema—qualitative and difficult to gauge degree of erythema accurately. Also varies with quality of radiation, and the texture of the skin.
5. Effect on *Drosophila* Eggs: Wood and Packard, and others, have carried out experiments in measuring the intensities of x-rays. This method has developed into more of a laboratory procedure.
6. The Thermal Method: This method could be used, but there is so little heat generated that it is almost impossible to measure it with the most sensitive instruments, and it would be still more complicated to measure small differences in x-ray intensities.
7. Ionization Method: This method has stood the test of time and has been adopted, with certain limitations, internationally as *the method* giving the greatest accuracy and the one most practical to use to standardize individual installations.

(a) At the Bureau of Standards, and a few other laboratories, an air ionization chamber is maintained.

(b) A thimble ionization chamber is compared directly with the air ionization chamber, and any wall effect is compensated for by direct comparison.

K. *Definition of the Roentgen*: "The quantity of radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in 1 c.c. of atmospheric air at 0 ° Centigrade and 76 cm. of mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current."

1. Secondary Electrons: X-rays passing through the gas between the plates of the ionization chamber strike a certain percentage of the atoms in their path and cause electrons to be ejected. The separated charges are called ions. The separated ions attracted to their respective plates of the ionization chamber collide with atoms and produce secondary ionization, or secondary electrons. The plates of the ionization chamber must be far enough apart to include all possible secondary electrons in order to measure the true ionization current.
2. To have the x-rays strike the walls of the ionization chamber would produce scattering and complicate the measurements, so the beam of x-rays is sent through diaphragms and the scattering eliminated.
3. Since the number of atoms in 1 c.c. of air varies with the atmospheric pressure and temperature, the roentgen must be that conductivity of air for some definite number of atoms in 1 c.c. Standard conditions have been chosen. When measuring x-rays at room temperature and at different barometric pressures, corrections must be made.

4. Saturated ionization current is that ionization current obtained when the voltage on the plates of the ionization chamber is such that all of the separated electrons will be attracted to the plates of the ionization chamber before they have a chance to recombine. If the force from the voltage on the plate is not as great as the force of attraction from the nucleus of the atom for the electron, some of the electrons will not reach the plates of the ionization chamber and the conductivity will be reduced.

*L. Measurement of Quality of Radiation:*  
The half value layer in copper, aluminum, etc.

1. A practical method of determining the half value layer is to measure the intensity through varying thicknesses of copper filter for deep therapy radiation and plot an absorption curve with filter thicknesses as abscissa and intensity in roentgens as ordinate. Note the intensity for 0.5 mm. Cu, reduce the intensity to half and find where a line drawn parallel to the abscissa passing through half of the intensity intersects the absorption curve. Draw a line parallel with the ordinate from the point of intersection to abscissa and note the corresponding millimeters of copper to give this intensity. The millimeters of copper to give half the intensity minus 0.5 mm. Cu represents the half value layer for radiation filtered by 0.5 mm. Cu. In the same manner the half value layer for radiation filtered by 1 and 2 mm. of copper can be obtained.
2. For 200 kv. radiation, copper is usually used to determine the half value layer; for superficial and skin therapy radiation, aluminum is probably better, due to the inability to get and use thin copper.
3. Effective Wave Length: The quality of radiation can be expressed in terms of that wave length of monochromatic radiation which will be

absorbed in the same manner as the heterogeneous beam of wave lengths under consideration, both having the same half value layer. Curves by Duane, Mayneord, those in "Science of Radiology," and elsewhere show the relationship between effective wave length and half value layer, or some other intensity relationships between varying filters and wave lengths. The effective wave length can be obtained only from some previously constructed curve with wave lengths plotted against corresponding half value layers in copper, aluminum, or other material, or some designated filters.

*M. Scattering of X-rays by the Tissue*

1. A percentage of x-rays scatter back to the surface of a phantom or to the skin of a patient.
2. The percentage of back-scattering varies with the size of the field. In a small field there will be less back-scattered x-rays because the x-ray beam is reduced and because there is not as much tissue from which to scatter as occurs in a large field.
3. The percentage varies considerably from the center of the field of radiation to the periphery.
4. The percentages of the primary beam scattering back to the surface for approximately the same quality of x-rays and size of field differ considerably from one investigator to another due to the type of ionization chamber used in measuring back-scattered radiation. The percentage difference for different square centimeter fields is quite similar among different investigators.
5. Back-scattered measurements vary with the quality of radiation. The percentage of back-scattered radiation is less with supervoltage radiation heavily filtered than with deep therapy.
6. Scattering beneath the surface of a phantom or skin:  
(a) With a large port of entry, there

is a greater depth dose than with a small field for the same reason as given for back-scattering; there are less x-rays to scatter.

- (b) As the x-rays scatter down into the tissue, the quality of the radiation changes. The effective wave length and half value layer changes, showing that the wave lengths are gradually becoming longer due to the quanta of x-rays losing energy by scattering. Failla and Quimby measured the half value layer on the surface of a phantom, and then at ten centimeters depth and found a reduction of the half value layer at ten centimeters.
- (c) In treating patients with x-rays, it is necessary to recognize that there is less radiation reaching a given depth as the port of entry is reduced.
- (d) It is helpful to determine the number of roentgens that can be safely given over fields of various sizes, remembering that the biological factor for small fields is a greater factor than the variation in back-scattering or the reduction in the depth dose.

#### N. Varying the Depth Dose

1. Varying the Filtration: Increased filtration up to a certain point will give a better depth dose.
2. Varying the Voltage: Increased voltage will give a better depth dose.
3. Varying the Skin-target Distance: Keeping all factors constant such as the size of field, filter, and voltage, the depth dose can be increased by increasing the skin-target distance. The increase can be computed by applying the inverse square law. If a 50-cm. skin-target distance is used and the loss of radiation at 10 cm. depth is computed,  $(50/60)^2$  equals 69.5 per cent. If a 70-cm. skin-target distance is used, the loss of radiation at 10 cm. depth is com-

puted,  $(70/80)^2$  equals 76.5 per cent. Take a depth intensity measurement at a depth of 10 cm. in tissue for a 50-cm. skin-target distance, and a given sized field to be 40 per cent. Since 40 per cent depth dose is based on 100 per cent at the surface, to find the percentage difference between the loss of radiation by changing the skin-target distance, it is necessary to divide 76.5 per cent by 69.5 per cent which equals 110 per cent. Forty per cent multiplied by 110 per cent equals 44 per cent depth dose for 70 cm. S.T.D.

#### O. Depth Intensity Curves (Called Iso-dose Curves)

1. Represent the percentage of radiation reaching various depths in the tissue compared to 100 per cent on the surface.
2. Loss of radiation as it penetrates the tissue—
  - (a) The radiation intensity is reduced due to the divergence of the x-ray beam, and can be computed by the inverse square law.
  - (b) The radiation intensity is reduced by the tissue totally absorbing some of the x-ray quanta.
3. There is a gain in the percentage of radiation intensity reaching various depths in the tissue due to—
  - (a) Scattering of radiation passing through the tissue increases the percentage of radiation reaching a depth.
  - (b) Percentage of radiation reaching a given depth in the tissue varies with the size of field because in reducing the size of the beam of radiation there are less x-rays to scatter.
4. The scattering back and forth of radiation that passes through and reaches a given depth in the tissue helps to offset the loss of radiation caused by divergence and total absorption of the rays.



# 5. Practical application of depth intensity charts—

- (a) Helpful in deciding upon the number and location of fields in attempting to deliver a pre-determined tumor dose.
- (b) Depth intensity charts are compared to anatomical cross-sections enlarged to the size of the patient, passing through the part of the patient to be treated. The tumor area can be outlined. The percentage of radiation reaching the tumor area can be compared to the radiation reaching each skin area.
- (c) Helpful in determining the percentage of exit dose which must be taken into consideration in totalling the radiation on each skin area.

An attempt has been made to give an outline that will enable those taking the *Course in the Physics of Radiology* to do some studying. A bibliography of physics books dealing with radiology and publications on various physical principles is given so as to enable one to carry on an organized method of study. A study of the Outline alone is not sufficient to acquaint one fully with the principles involved.

It is evident that in attempting to cover the foregoing subjects, it will be necessary to move rather rapidly. Thus, in order to obtain the most from such a course of lectures, it is necessary to have the undivided attention of those attending. The Outline eliminates the necessity of taking notes, since each one attending will receive a copy of the Outline.

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# CONCERNING THE DIAGNOSIS OF LESIONS IN THE LOWER SPINAL CANAL

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**P**AIN in the lower back, radiating into one or both legs is a common ailment; one for which many remedies have been proposed and probably as many theories of its etiology offered. Until

of reported cases of low intraspinal lesions causing low back pain, particularly herniated nuclei pulposa (1, 2, 3, 4, 5, 6, and many others), and hypertrophied ligamenta flava (7, 8, 9, 10, 11), prompts the

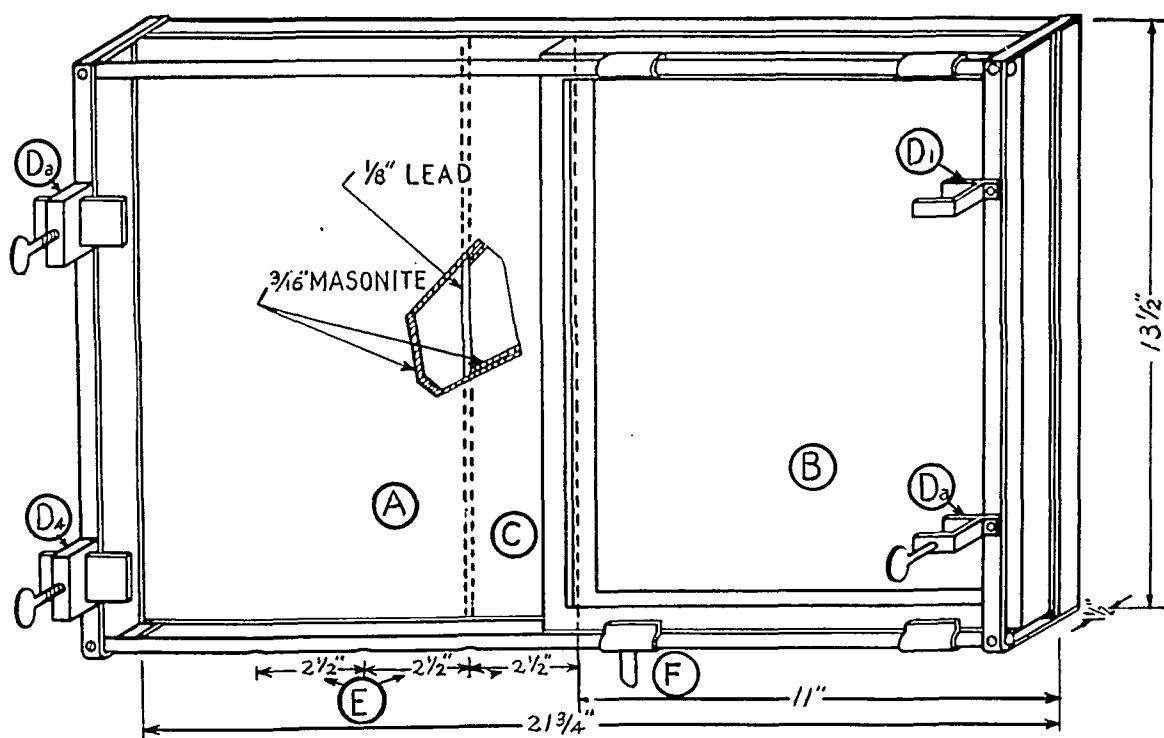


Fig. 1. Serial spinal tunnel showing construction, shifting mechanism, and provision for attachment to fluoroscopic screen. A—Lead-protected area for exposed portion of film; B—Lead-protected area for unexposed film; C—Unprotected area for fluoroscopic observation and serial film exposure; D—Apparatus for attaching tunnel to fluoroscopic screen; E—Stop-notches for control of shifting mechanism; F—Metal handle with spring plunger attached to movable cassette carrier.

comparatively recent years, most investigators' attention has been focused upon extraspinal causes: the sacro-iliac joints, postural deformities, fascial bands, taut piriformis muscles, the vertebral articular facets, and ill-defined toxic, allergic, or infectious involvements of peripheral nerves. Intraspinal lesions, if considered at all, were listed near the end of the differential diagnosis. The steadily increasing number

suggestion that these lesions are far more common than generally supposed.

Accurate localization of tumors in the lower lumbar neural canal from clinical findings alone has been and probably will continue to be, a difficult problem, due to anatomical peculiarities of the region. In the first place, lesions of the cauda equina may produce symptoms identical to lesions of the corresponding peripheral nerves. Unless

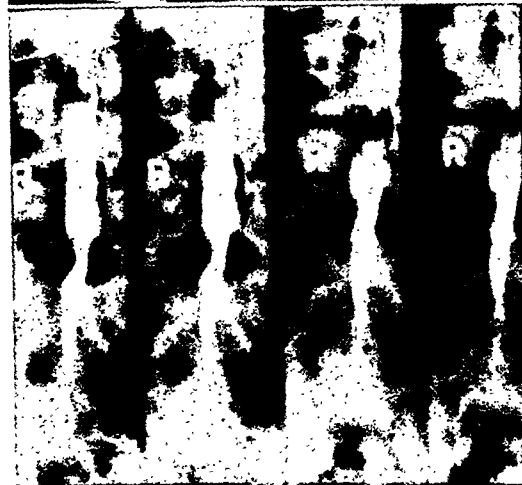
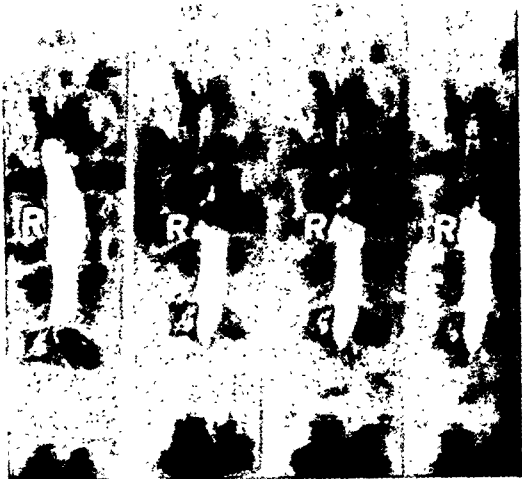


Fig. 5. Large herniated nucleus with complete subarachnoid block at level of fourth lumbar vertebra. Neurologic examination in this case completely negative. Only symptom, intractable pain over period of ten years.

Fig. 6. Small herniated nucleus pulposus at fifth lumbar interspace. Only defect noted was absent fifth lumbar root sleeve on left. Patient totally incapacitated by intractable pain in left leg

for two years. Neurologic examination showed sensory loss in skin distribution of left fifth lumbar nerve.

Fig. 7. Small herniated nucleus pulposus at fifth lumbar interspace. Two exposures on right show an apparently normal column. The two exposures on left show column passing upward. As the column thins out the obvious defect on the right appears.

may be changed from horizontal to upright at will. The patient's position is adjusted so that the portion of the spine being examined is directly beneath the unprotected area in the tunnel. Portions higher and lower may be examined by moving the screen with the attached tunnel upward or downward. The table is slowly tilted toward the upright and the progress of the lipiodol column is observed as it descends in the canal. If a filling defect is noted at any point serial films are made as the column passes this area.

The patient is raised until the column descends into the lowest limit of the sacral canal after which the head is gradually lowered and the progress of the material is observed as it passes upward in the canal. The progress of the column upward is observed to a point well above the level under suspicion as indicated by the neurologic study. No abnormality may be observed in the lipiodol column during the fluoroscopic examination in an area where the neurologic examination indicates that there is pathology. In this circumstance we make serial films of the suspected area while the column is passing it, for on more than one occasion a lesion has been shown in films that has not been detected with the fluoroscope. The value of the films made in the oblique positions has been discussed by previous writers (6). We have found such films to be most helpful in demonstrating small lesions and we now use them routinely.

Theoretically, one should be able to distinguish between a displaced nucleus and an hypertrophied ligament by lateral films. However, this is seldom the case, for nuclei usually herniate lateralward beneath the nerve root and the ligaments

frequently hypertrophy more on one side than the other. We have found it impossible in most cases to differentiate the two lesions by lateral films and, therefore, they are now used infrequently.

produce gross filling defects in the portion of the subarachnoid space where they are found. Such filling defects are readily demonstrated and at times produce a "complete block" below the level of which

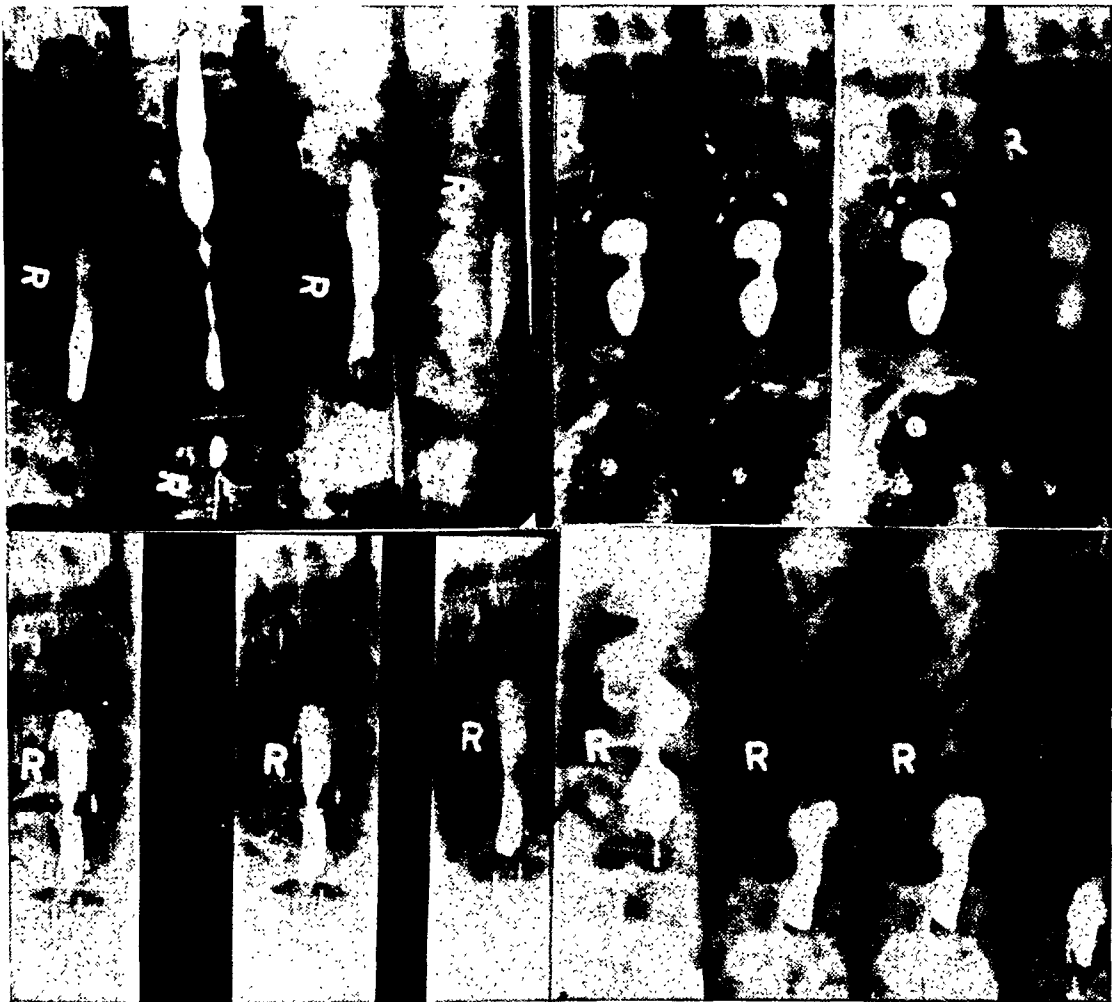


Fig. 8 (*above left*). Small herniated nucleus pulposus fourth lumbar interspace. Films made at different levels as column passes upward and downward in canal. Findings considered to be negative. Small partial filling defect at fourth lumbar interspace overlooked.

Fig. 9 (*below left*). Same case as Figure 8. Films made six months later without re-injection of lipiodol. Obvious filling defect at fourth lumbar interspace on left now present.

Fig. 10 (*above right*). Hypertrophied ligamentum flavum fifth lumbar interspace. Major defect on right side. Symptoms were low back pain radiating into right leg. Examination showed sensory loss in all sacral segments.

Fig. 11 (*below right*). Combined lesion: hypertrophied ligamentum flavum fourth lumbar interspace on left; herniated nucleus pulposus fifth lumbar interspace on right.

#### INTERPRETATION OF ROENTGEN-RAY FINDINGS

Large lesions, whether herniated nuclei pulposa, ligamenta flava, or neoplasms,

it is impossible for lipiodol to descend by gravity (Figs. 5 and 12).

Small lesions may encroach upon the subarachnoid space slightly, if at all, yet

a lesion so small that demonstration by x-ray is difficult, may produce fulminating, disabling symptoms. Fortunately, in these cases the neurologic study usually indicates the probable location of the lesion

the place where it comes to rest. Most of our cases have shown unilateral filling defects (Figs. 7, 9, 10). Two have shown a complete block (Fig. 5). There was also a complete block of the canal with symp-



Fig. 12. Neurofibroma at level of fourth lumbar vertebra. Almost complete subarachnoid block. Only symptom, pain radiating into left leg. Neurologic examination negative.



Fig. 13 (above). Constant filling defect fourth lumbar interspace. Films show column of lipiodol passing progressively downward through the area of narrowing in the canal. Large herniated nucleus pulposus removed at operation.

Fig. 14 (below). Anteroposterior and lateral films of same patient as Figure 13. These two illustrations show the kind of films that are secured with our present technic and equipment.

and as a result the roentgenologist may use these findings as a guide for his study. Obviously, fluoroscopic examination alone in such a case may be of little help inasmuch as no gross defect in the lipiodol column is produced. It is only when viewed on the serial films that abnormalities about the root sleeves and small variations in the shape of the lipiodol column are observed. Furthermore, at times these small defects are not demonstrated during the downward passage of the lipiodol column. It may be only in the upward passage, when the column becomes relatively thin, that they become apparent (Figs. 6, 7, and 8).

The filling defects produced by herniated nuclei depend upon the size of the cartilaginous mass extruded into the canal and

toms identical to those in the two just mentioned with herniated nuclei in the case illustrated in Figure 12; but in this instance the block was due to a neurofibroma.

In some instances the extruded nucleus may come to rest in the intervertebral foramen and impinge upon the root of the corresponding nerve with consequent

irritation of the nerve due to pressure. This is followed by swelling of the affected nerve and may cause obliteration of the space about the root (choked root, Fig. 6).

There is great variability in the filling of the root sleeves. It is our impression that they are more readily demonstrated if the lipiodol injection is done some hours prior to the roentgenographic examination. It is certain that an absent root sleeve should not be considered abnormal unless the neurologic examination shows definite evidence of disease at this level. The position of the root sleeve is frequently abnormal in either of the lesions under consideration due to pressure upon the nerve by the lesion.

In hypertrophy of the ligamenta flava the enlargement is usually asymmetrical, and involves chiefly, one or the other of the lateral extremities of the ligaments and for this reason they usually produce unilateral defects (Fig. 10). However, we had one case in which there was a complete subarachnoid obstruction, and not infrequently an "hour-glass" defect is observed.

Combined lesions may be present and result in multiple filling defects at different levels. An illustrative case is shown (Fig. 11). The large filling defect on the left at the fourth lumbar interspace was noted at the first examination but the defect on the right at the fifth interspace was overlooked. At operation a markedly hypertrophied ligamentum flavum was found at the fourth lumbar interspace and removed. All of the patient's symptoms disappeared except localized pain in the skin distribution of the right fifth lumbar nerve. Our films were reviewed and the then obvious filling defect on the right corresponding to the area indicated by the neurologic signs was found. At the second operation a small herniated nucleus pulposus was removed. This operation was followed by complete relief of all symptoms.

A careful review of our cases has failed to reveal any one finding or group of findings which will permit one to differentiate between abnormalities of the nuclei pul-

posa and ligamenta flava with any degree of certainty. Since the treatment of the two lesions is the same this lack of differentiation is of little practical importance.

Narrowing of the intervertebral joint space has been present in some of our cases with herniated nuclei but this has been by no means a constant finding. On the other hand, grossly narrowed joint spaces have been found frequently with nothing either in the neurologic or roentgen-ray findings indicative of pathology within the canal at the level of the narrowed space.

#### SUMMARY

The neurologic and roentgen-ray findings in two of the lesions that may cause low back pain have been discussed.

Illustrations showing the roentgen-ray findings in ten cases operated upon are included.

The opinions expressed are based on the study of 40 cases operated upon in which an hypertrophied ligamentum flavum, a herniated nucleus pulposus, or both, were found in each, and removed.

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# RADIUM PROTECTION

## PREFACE

THE rapid increase in the use of radium during the last few years, resulting in the acquirement of large amounts of radium by various institutions, has brought with it the need for better safeguards and rules to protect the users from the radiation. The dangers arising from exposure to the radiation from radium are in some cases now well known; in others, still obscure and uncertain. Sufficient experience and data are now available, however, to show with fair conclusiveness that with reasonable precautions radium can be handled over a considerable period of years with no apparent harm.

On the other hand, serious injury has resulted from relatively short periods of work with radium in cases in which certain precautions were overlooked. Even when proper working conditions and suitable regulations exist, there is still the potential danger of excessive exposure as a result of improper use of safety equipment and violation of good practice. Since the injury does not become apparent immediately, workers may frequently be tempted to neglect routine precautions.

The National Bureau of Standards has been engaged in the standardization of radium for medical purposes since 1913 and during this period has measured nearly all radium offered for sale in this country. The large amount of radium which has passed through our laboratory has made it necessary to give considerable attention to this problem of radium protection. But, the study of the biological effects of the radiation falls outside the field of our activities, and when the problem arose of revising Handbook No. 18, setting forth proper conditions for handling radium in the light of present-day knowledge, we turned again to the Advisory Committee on X-ray and Radium Protection. The following members compose this Committee:

Representing International Safety Committee and National Bureau of Standards for X-rays: LAURISTON S. TAYLOR, Physicist.

Representing American Roentgen Ray Society: E. R. PENDERGRASS, M.D., University of Pennsylvania Hospital, Philadelphia, Pa; J. L. WEATHERWAX, Physicist, Philadelphia General Hospital, Philadelphia, Pa.

Representing Radiological Society of North America: R. R. NEWELL, M.D., Stanford University Hospital, San Francisco, Calif.; G. FAILLA, Physicist, Memorial Hospital, New York City.

Representing the American Medical Association: FRANCIS CARTER WOOD, M.D., St. Luke's Hospital, New York City.

Representing X-ray equipment manufacturers: W. D. COOLIDGE, Director, Research Laboratory, General-Electric Company, Schenectady, N. Y.

Representing the American Radium Society: CURTIS F. BURNAM, M.D., Howard A. Kelly Hospital, Baltimore, M.D.

In response to the Bureau's request, Dr. Burnam, Dr. Failla, Dr. Newell, Dr. Weatherwax, and Dr. Wood kindly undertook the revision of the handbook. Dr. L. F. Curtiss, representing the National Bureau of Standards for Radium, acted as secretary to the Committee.

The regulations set forth in the following pages are the results of their joint recommendations regarding safe methods of handling preparations of radium used in radium therapy. I wish to express to the Committee my sincere thanks for their co-operation in the preparation of this handbook.

LYMAN J. BRIGGS, *Director.*

## 1. GENERAL CONSIDERATIONS

### *Protection Rules and Their Application.*—

It is well known that over-exposure to the radiations emitted by radium or other

radio-active substances may result in serious injuries. However, the experience of the last twenty-five years provides a satisfactory basis for the protection of those engaged in radium work.

The most important point is for the radium worker to have an ever-present realization of the danger and to carry out all manipulations in such a way as to reduce the exposure to a minimum. If this principle is strictly adhered to, there is no danger of irreparable damage being done before warning signs manifest themselves.

The recommendations given in the following paragraphs are intended to serve as a guide to radium workers and employers. Naturally, they must be followed judiciously to meet special problems which may arise in different laboratories. It should be borne in mind, however, that whatever means of protection are provided in any particular laboratory or clinic, they must be sufficient to prevent permanent injury, whether local or systemic, when instructions are properly followed by the worker.

Before an individual is employed to handle radium, he shall be informed of the dangers involved. He shall then be instructed to make proper use of the necessary safety measures provided in the laboratory or clinic. It is suggested that radium workers familiarize themselves with the recommendations contained in this Handbook.

1.01. Protection for radium workers is required from the effects of (1) local over-exposure to radiation, especially upon the hands, and (2) over-exposure of the entire body.

1.02. In either case, adequate protection may be secured most readily by distance and brevity of exposure.

1.03 All manipulations shall be carried out as rapidly as possible and with the hands and body as far from the radium as practicable. No radium preparation must be allowed to come in contact with any part of the technician's body (especially the hands) at any time.

1.04. Radium workers shall not remain

in proximity to radium when not engaged in necessary manipulations.

1.05. The chart, Figure 1, gives the combinations of lead thickness and distance for different amounts of radium, which provide adequate protection for exposures not exceeding seven hours daily. (*Note*:—Continued exposure of technicians for a number of years, under the conditions stipulated in the chart, has been found to be safe at Memorial Hospital, New York. The tolerance gamma-ray intensity derived from the chart is approximately 0.1 r per day.) Table I gives typical values obtained from the chart to illustrate its use.

TABLE I

Milligrams of Radium	Thickness of Lead	Distance
10	0.5 cm.	70 cm.
	1 cm.	60 cm.
	2 cm.	45 cm.
100	1 cm.	185 cm.
	2 cm.	140 cm.
	3 cm.	105 cm.
1,000	1 cm.	570 cm.
	3 cm.	340 cm.
	6 cm.	160 cm.
5,000	4 cm.	550 cm.
	6 cm.	350 cm.
	10 cm.	220 cm.

1.06. All storage containers shall be at as great a distance as convenient from any place habitually occupied by any person, but in no case shall the combination of distance and screening (whether by lead or equivalent thicknesses of other materials) be less than indicated in the above-mentioned chart.

1.07 It is recommended that whenever possible the amount of radiation to which a person is subjected during the entire working day be measured by a suitable integrating device over a long enough period to be representative of average working conditions.

1.08 Photographic films carried in a pocket during working hours may be used as a rough test of protection. Ordinary "dental film" with a paper clip is convenient for this purpose. The paper clip helps to distinguish between exposure to hard gamma rays and exposure to soft radiation—largely beta rays. If the film

shows decided blackening after being carried two weeks, conditions should be investigated to determine whether this is due to local exposure or is indicative of the exposure which the entire body receives. In the latter case, steps should be taken to reduce the general exposure of the body to a safe limit. Moderate darkening of ordinary dental films in two weeks' exposure may be taken as a rough indication that the general radiation is within the tolerance limit. It should be borne in mind that film tests of this sort are not very satisfactory. X-ray films are so sensitive that a certain degree of darkening is always found in dental films carried by radium workers for two weeks. It is impossible to make a close estimate of the radiation received by the film without elaborate experiments and careful measurements of the photographic density. A film showing marked blackening from *local exposure* does not necessarily indicate dangerous working conditions.

## II. PERSONNEL

2.01. The effects on the human body of continued exposure to low radiation intensities are not well known.

(a) Over-exposure of the entire body or a large part thereof may cause eventually a lowering vitality, with a general feeling of lassitude and frequent headaches.

(b) Extreme over-exposure of the entire body may result in the development of anemia or, possibly, leukemia.

(c) Over-exposure of some part of the body (*e.g.*, the hand) may result in local "radium burns" which are very refractory to treatment and may eventually become malignant.

2.02. Complete blood counts shall be taken every month for persons regularly working with radium.

(a) A complete blood count consists of the following determinations: Hemoglobin test, red, white, and differential counts, the latter including percentages of polymorphonuclear cells, small and

large lymphocytes (separately), eosinophiles, and basophiles. In addition, a blood-platelet, sedimentation, and coagulation tests are of value.

(b) Blood counts of one individual taken at different times of the day may vary considerably. Accordingly they should always be taken at the same hour, particularly, with respect to meals. If possible, the same technician employing the same method and technic should take all counts for one individual.

(c) Blood counts of different individuals may vary considerably within normal limits. Therefore, the absolute values of the different counts are not so important as the relative values of corresponding counts from month to month. A downward trend of the white count and of the percentage of polymorphonuclear lymphocytes, over a period of a few months, may be taken to indicate the possibility of over-exposure. The matter should be investigated immediately.

(d) Before employing a technician for radium work, a complete blood count should be taken. This, together with the first few monthly counts (before appreciable change from radiation may occur), may be taken as the normal count for the individual. No one should be employed as a radium technician if there are unaccountable abnormalities in his blood count.

(e) In appraising the significance of changes in blood counts within the first few months, all factors should be considered, including particularly the previous occupation of the individual (*e.g.*, whether outdoors or indoors).

(f) Since blood counts of normal individuals ordinarily vary within wide limits among themselves and from time to time for the same person, one must beware lest a blood count which is within these limits, lull one into a false sense of security. As already pointed out, more attention must be paid to the trend of successive counts than to absolute values. It is suggested that all counts

be made under the direction of a skilled hematologist to detect the earliest deviation from normal.

2.03. A thorough physical examination of a radium worker should be made before he is employed and at any time that the blood count shows suspicious changes or the individual complains of some obscure ailment. In the physical examination, particular attention should be given to teeth, tonsils, and focal infections, also to the condition of the skin on the hands.

(a) Individuals with dry skin having a tendency to crack, a skin with warts, or a skin showing signs of abuse (cuts, cracks, etc.), should not be employed for radium work. (Dirty nails indicate that an individual is apt to abuse his hands in manual work and he should not handle radium.)

2.04. The hands of a radium technician shall be examined at regular intervals.

(a) The first effect of local exposure manifests itself as a reddening and shiny appearance of the skin of the fingers next to the nails.

(b) Later, nails may assume an abnormal curvature, either up or down, and with continued exposure become brittle.

(c) The skin at the end of the index finger and the thumb may become somewhat leathery and may lose its characteristic ridges. This may be taken as a definite indication that the individual is careless and, on occasion, handles radium with his fingers.

(d) At what stage the individual should stop working with radium depends on circumstances. However, a radium technician should be informed of the occupational hazards at the outset and should be reminded of them from time to time. He should not be promised permanent employment.

2.05. Individuals with faulty vision, which cannot be corrected properly by glasses, shall not be employed for radium work.

2.06. Radium technicians who have been employed more than a year should

have four—and preferably six—weeks' vacation a year. This should be arranged to permit four weeks during the summer and two in winter. Technicians should be urged to spend as much time as possible outdoors, both during vacation and after working hours. If other methods of reducing exposures, such as intermittent employment in radium work, are used, the vacation period can be reduced.

2.07. Precautions shall be taken to protect nurses in charge of patients receiving radium treatments, and other persons who, in the performance of their duties, are subjected to radiation from patients under treatment.

(a) Distance and length of exposure are the two factors which can be controlled most readily for the protection of such personnel.

(b) Table II gives the distances at which it is safe for a person to be, for a period of years, from patients receiving different milligram-hour doses daily. (The influence of walls and objects in the path of the rays has not been taken into account in Table II).

TABLE II

Daily Exposure (mg.-hr.)	Safe Distance (meters)
100	0.9
200	1.3
400	1.8
800	2.5
1,600	3.6
3,200	5.0

(c) Nurses who regularly attend to patients being treated with radium should perform their duties which bring them close to the radium as rapidly as possible and should then remain as far as practicable from the patient or patients.

2.08. In institutions where large quantities of radium are used for the treatment of patients special precautions shall be taken to prevent over-exposure of nurses and secretaries as well as radium technicians.

(a) The nature of these precautions depends largely on local factors and

conditions. It is suggested that, whenever possible, nurses assigned to radium cases be rotated and that patients receiving radium treatments be widely separated.

(b) Monthly blood counts should be taken if a preliminary survey based on the figures of Table II suggests the possibility of over-exposure.

### III. STORAGE

3.01. When not in use or transit, all radium shall be stored in a protective inclosure.

3.02. This inclosure shall provide sufficient protection to all persons, whether employees or not, who may periodically come within the "danger range" of radium. The "danger ranges" of different quantities of radium filtered by no less than 1 mm. of lead or its equivalent, for different daily exposures, are given in Table III.

TABLE III<sup>1</sup>

Amount of Ra. El. (mg.)	Daily Exposure in Hours				
	1	2	4	8	16
	Danger Range in Meters				
100	0.9	1.3	1.8	2.5	3.6
200	1.3	1.8	2.6	3.6	5.1
400	1.8	2.5	3.5	5.0	7.1
1,000	2.9	4.0	5.7	8.0	11.3

<sup>1</sup> Values based on Protection Chart, Figure 1.

3.03. The amount of absorbing material to be provided in any one direction depends on:

(a) The distance at which the person to be protected may be.

(b) The period of time during which the person may remain at this distance.

(c) The influence which the amount of absorbing material affording sufficient protection in any given direction may have on the intensity of radiation at other points to be protected. (*Note*:—It is not sufficient to place a large quantity of radium near an outside corner of a room behind a lead plate, no matter how thick. The protection for people outside will be more than sufficient, but inside the room there may be too much scattered radiation.)

3.04. In any event, sufficient protection shall be provided to reduce the general body radiation to which a person may be exposed to 0.1 r per day for the person in question.

3.05. In the case of individuals who are apt to handle radium for a number of years, account must be taken of the exposures and correspondingly greater protection from stored radium must be provided.

3.06 The protective inclosure may be constructed of any suitable material. If any material other than lead is used, it is important that the equivalence to the necessary lead thickness, derived from the protection chart for any given case, be determined under proper conditions. Absorption measurements made with narrow beams of gamma rays are not satisfactory for this purpose.

3.07. The protective material should surround the radium and should be as close thereto as practicable. This is not only more economical but makes the source of scattered radiation (the inclosure itself) smaller. (*Note*:—A large concrete wall of insufficient thickness to absorb *all* the radiation provides more scattered radiation into an adjacent room than the same thickness of concrete placed immediately around the radium.)

3.08. The protective inclosure shall be constructed in such a way as to minimize as much as possible the exposure of technicians in the handling of the radium. The most important factors to consider are:

(a) Distribution of the radium.

(b) Protection of subdivided amounts.

(c) Time required by technician to remove or return a particular applicator to the inclosure.

3.09. The radium supply should be subdivided in small lots in the protective inclosure, each lot being placed in a suitable, protected compartment. The number of tubes or needles which may be placed in each compartment, depends on the radium content of the preparations and the number of units which are generally grouped

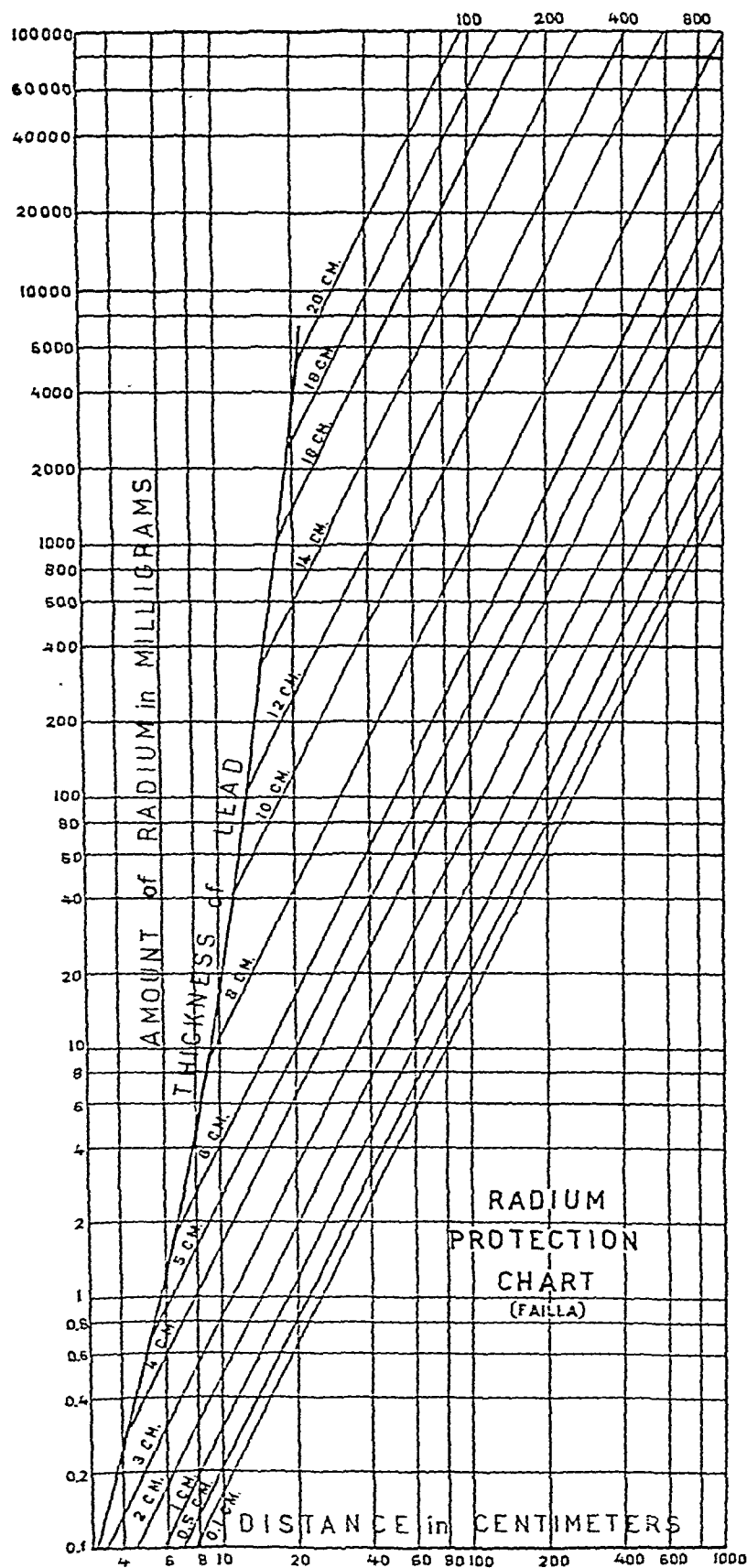


Fig. 1. Radium protection chart showing distances at which it is considered safe for an individual to be for a number of years during working hours (not exceeding eight hours daily) for various amounts of radium and lead screening. The chart is based on actual experience with radium technicians. It is interesting to note that under the conditions stipulated in the chart, the individual is exposed to approximately 0.1 r per day, which is within the range of tolerance intensity generally accepted for x-ray workers.

together in the treatment of average cases.

3.10. Separate compartments should be provided for different types of applicators and for those of distinctly different radium content.

3.11. Each compartment should be labelled or otherwise marked so as to permit immediate and certain identification of its contents from the outside.

3.12. It is highly desirable that tubes, cells, needles, etc., be readily identifiable from a considerable distance as to their radium content. When sizes and shapes are not adequate other means should be employed, such as plating or enamelling with different colors.

3.13. The protection of the individual compartments and the inclosure as a whole should be such that a technician standing in front of the inclosure in performance of his duties receives in that time only a fraction of the allowable daily body dose.

## IV. MANIPULATION AND PREPARATION

4.01. The exposure to radium radiations of technicians, nurses, and all individuals who handle radium, shall be reduced as much as practicable by providing suitable equipment and accessories.

4.02. Such equipment shall be designed to permit the necessary operations to be carried out expeditiously at a considerable distance, and behind protective screens—the three factors being properly adjusted with respect to the influence of one upon the others.

4.03. The preparation of radium applicators or similar operations shall be carried out behind a lead L-block of a minimum thickness of 5 cm. in the direction of the technician, and of such size as will shield the entire body.

(a) The block should be of such height that when placed on a table, the technician can look over the edge comfortably when standing.

(b) The top of the L-block should be provided with an inclined lead glass "visor" equivalent to at least 1 mm. of metallic lead, if unfiltered radium or radon is to be handled.

(c) The side of the block next to the technician should have a protective pad to keep his body at least 20 cm. from the point where the radium is handled.

(d) The inside corner of the L should be curved so as to increase the lead thickness at the level where the radium is closest to the body and to insure that the manipulations are carried out at a considerable distance from the corner.

(e) The lead block should be covered with wood, "linoleum," or other material of low atomic weight.

4.04. Vises or clamping devices should be provided at the lead block to facilitate preparation of applicators. Preferably these devices should be operated by foot pedals.

4.05. Forceps for handling radium should be designed specially for this use. In general:

(a) They should be as long as the operation to be carried out permits, taking into account speed and preciseness of manipulation.

(b) They should grip the radium containers firmly with a minimum of force exerted by the fingers. Spring operated self-clamping forceps are desirable where practicable. The jaws should be notched, grooved, or otherwise formed to fit the applicators to be handled.

(c) Forceps 25 to 30 cm. long are recommended for general purposes. They should be light in weight to permit rapid and accurate manipulation. If unfiltered specimens are to be handled, forceps should be provided with metal gauntlets of sufficient thickness to absorb all primary beta rays.

(d) Forceps used to lift easily damaged preparations should have a "spring tip" adjusted to prevent excessive pressure on the specimen.

(e) Cross-action forceps are desirable for some delicate manipulations.

4.06. A suitable device should be provided for threading needles or tubes expeditiously with the fingers protected as much as possible by distance and lead barriers.

4.07. Rooms in which radium is handled must be properly lighted and ventilated. Special operations may require individual lighting.

4.08. A lead-lined "well" should be provided near the lead L-block, to hold radium preparations required for an applicator while it is being made up. The "well" should be covered by a heavy lead top on suitable rollers so that it can be moved to the open position by a foot lever and returned to the closed position by gravity.

4.09. Radium technicians should be supervised to make sure that they take advantage of the protective devices provided. Injuries from over-exposure to radium rays do not manifest themselves for days, weeks, or months. This is apt to lead to carelessness. New technicians must be instructed properly at the start, and the dangers of over-exposure impressed

on them. All operations should be planned outside the preparation room and then carried out rapidly, so that the time spent in handling the radium is only that absolutely necessary to carry out the required manipulations.

4.10. In spite of all precautions, radium technicians who work with large quantities of radium are subjected to higher radiation intensities than those to which it is definitely safe to be exposed for several years. When this is the case, blood counts and fingers should be watched carefully, and appropriate steps taken as soon as indications of slight over-exposure appear.

## V. RADON PLANTS

5.01. To avoid danger of inhalation of radon by the operator, thorough ventilation (at least eight complete changes per hour) of the room in which radon pumping equipment is located is essential. Exhaust fans should draw air from near the floor and discharge it into the open air through as short ducts as practicable. Ventilation fans should be turned on at least a half-hour before the room is to be occupied, unless means are provided to detect possible leakage of radon.

5.02. Lead screening shall be provided for all parts of the radon apparatus in which radon accumulates, including the connecting glass tubing where the most radon will collect.

5.03. Manipulations of radon bulbs and seeds shall be carried out as far as possible immediately after they have been sealed from the pumping apparatus, while the active deposit is at a minimum.

5.04. Automatic pumping equipment or apparatus equipped with remote controls is recommended for radon pumping.

5.05. Exposures are of the same character as for radium of the equivalent amount of filtration. Therefore, all recommendations contained in this handbook for screening, storage, and manipulation of radium preparations apply equally to preparations of radon.

## VI. TRANSPORTATION WITHIN AN INSTITUTION

6.01. Containers for carrying radium shall provide adequate protection from local injury (*e.g.*, burns) and general systemic disturbances in individuals handling the container, based on the longest possible time that the individual may carry the package or packages at any one time or repeatedly in the performance of his duties.

6.02. The required protection may be obtained by a suitable combination of lead screen completely surrounding the radium.

(a) Radium carriers should be designed to conform with the specifications given in Table IV as to lead thickness and distance of the radium from the handle.

(b) The handle of the carrier should be so arranged that it is easier to carry it by the handle than in any other way.

(c) Hand carriers should not weigh more than 10 kg. and should be provided with long handles which bring the radium close to the floor in the normal carrying position. The lead lining at the bottom may be half as thick as that of the sides and top.

TABLE IV

Amount of Radium (mg.)	Lead Thickness (or Equivalent) (cm.)	Minimum Distance from Radium to Handle (cm.)
10	0.1	25
	1.0	18
20	0.1	35
	1.0	26
40	0.1	50
	1.0	37
100	1.0	60
	2.0	45
200	2	64
	3	50
400	2	90
	3	70
1,000	2	140
	3	110
	4	80

(d) Radium carriers which weigh much more than 10 kg. should be mounted on wheels.



(e) All radium carriers should be constructed so as to reduce to a minimum the time required to place applicators therein and remove them and at the same time permit all operations to be carried out with the technician's hands at a considerable distance from the radium.

6.03. In the case of an individual who may transport radium for many years, the average total dose must not exceed 0.1 r per day. In estimating the body dose, one may take the distance of the radium from the umbilicus as a rough approximation to the average effective distance.

6.04. It is suggested that, especially in institutions or laboratories where large quantities of radium are handled, radium technicians be relieved as far as practicable from the task of transporting radium preparations from one room to another. This may well be done by employees who are not continually exposed to radiation. It should be noted in this connection that the specifications of Table IV are not so stringent as those for the storage of radium. The body dose resulting from carrying radium seven hours a day under the conditions set forth in the table is approximately 1 r per day.

6.05. When radium is transported from a hospital or laboratory to a doctor's office or patient's home, precautions should be taken to prevent injury to the person carrying it.

(a) The radium carriers for this purpose may be those used for transporting radium within the hospital proper, or they may be specially designed, depending on conditions.

(b) Insofar as practicable, technicians regularly engaged in radium work should not be required to transport radium in this way. At any rate, the exposure to which a technician is subjected in the course of transporting radium must be taken into account.

(c) Individuals who transport radium regularly in public conveyances shall be instructed to place the container on the floor and to stand, rather than sit, near

it. In automobiles, radium should be placed as far as possible from persons who work with it regularly.

6.06. When radium is sent out of the hospital or laboratory by a messenger who is not familiar with the dangers of over-exposure, the container or package shall be such as to preclude the possibility of local injury.

(a) The combination of lead thickness and minimum distance of the radium from the surface of the container given in Table V provides sufficient protection from *local injury* with a large factor of safety:

TABLE V

Amount of Radium (mg.)	Lead Thickness (or Equivalent) (cm.)	Minimum Distance from Surface (cm.)
10	0.1	3.5
	0.1	5.0
	0.5	4.4
	1.0	3.75
50	0.1	7.9
	0.5	6.9
	1.0	5.9
100	0.1	11.1
	0.5	9.8
	1.0	8.3
200	0.1	15.7
	0.5	13.7
	1.0	11.7

(b) It is desirable to add a handle to the box or container to bring the radium close to the floor in the normal carrying position.

(c) Special carrying cases may be provided for such transportation of radium. If they are constructed in such a way that in the obviously most comfortable carrying position the radium is close to the floor, they may be of smaller dimensions than indicated in Table V.

## VII. TRANSPORTATION BY COMMON CARRIERS

7.01. Shipment of radium, radon, or similar radio-active substances through the mails is prohibited by postal regulations

in the United States. This regulation is intended to prevent fogging of photographic films.

7.02. Shipment of radium up to 100 mg. in a single shipment may be made by railway express when the package is plainly marked as containing radium and is provided with lead screening sufficient to protect super-speed X-ray films. Details may be obtained from local express agents.

#### VIII. UNUSUAL CONDITIONS

S.01. It is impossible to deal with unusual conditions within the scope of this handbook. Among such are refineries of considerable amounts of radium, unusually large amounts of radium in a single institution. It is the opinion of the Committee that in such situations a special survey should be made, with competent expert advice to determine necessary safeguards.

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## WHAT IS THE ISSUE?

For a number of years there has existed a controversy, which occasionally and in certain communities has flared into warlike proportions, between organized hospitals and the organized medical profession concerning the practice of medicine in hospitals. Particular interest has centered around the specialties of radiology, pathology, anesthesiology, physical therapy, and others which are closely identified with the treatment of patients during hospitalized illness.

During recent years the question has been brought to a head by the advent of hospital insurance and by the determination on the part of some hospital administrators, met by decreasing endowment income, to augment hospital income from fees paid for medical services performed in the hospital. To make hospital insurance more salable they have demanded that certain medical services be included in the benefits offered by the hospital. To secure needed revenue they have employed specialists on a salary or commission basis, sufficiently low to permit, in some cases, a net income to the hospital after all expenses are paid.

Organized medicine has steadfastly insisted that the quality of medical care and the future progress of medicine will suffer if private practice be supplanted by institutionalized practice, delivered, sold, and controlled by a third party corporation, hospital or otherwise. Medical practice, says the profession, is the function of doctors and the physician's relation to his patients must not be complicated by a corporate distributing agency. Hospitals, they say, are institutions where doctors may treat the sick, retaining the same professional relationship with the patient that they have in the home or private office.

The American Hospital Association, representing the organized hospital world, has, with a good deal of emphasis, expressed an opposite view. The hospital, they say, is more than a place where doctors treat their patients. It is an institution which provides not only facilities but medical service. In this day of corporate structure and mass production, the hospitals say their function includes the provision of certain medical services through the medium of

employed physicians under salary or commission contracts.

With diametrically opposed "principles" promulgated by first one side and then the other, and with prejudiced opinion presented as fact, it seems desirable that an attempt be made to clearly define the issues.

The medical profession recognizes that improvements in hospital facilities and administration have been partly responsible for the tremendous strides of medical science and the high quality of medical care enjoyed by the American people to-day. Hospital administrators are no less generous in their praise of the physician for his humanitarian contributions to the public welfare.

The differences arise in the field of economics. The medical profession demands that the hospital meet its financial obligations with revenues from its endowments, its income from charities, its profits on the rental of its rooms and facilities and the sale of its *hospital* services. It denies the hospital's right to earn a profit from the sale of physicians' services.

The American Hospital Association insists that the hospital has a right to provide certain medical services, along with its hospital facilities. Says the Board of Trustees of the A.H.A., "Provision of medical services in hospitals is part of the responsibility of the hospital." W. P. Slover, a hospital superintendent, writing in the *Journal of the A.H.A.*, advises hospitals to increase their revenue by educating the public to "more regular use of the laboratory, the x-ray and diagnostic services for systematic check-ups on their health."<sup>1</sup> It seems apparent that this may place the hospital corporation in competition with private physicians. Editorially, the same *Journal* declares that, "Diagnosis, treatment, and care of the ambulatory sick become increasingly the function of the hospital, as the hospital develops into the center of community health activities."<sup>2</sup>

It is generally recognized that corporations, being artificial legal entities, cannot be licensed

<sup>1</sup> *Hospitals*, June, 1938, p. 50.

<sup>2</sup> *Hospitals*, May, 1937, p. 73.

and are, therefore, not permitted to practise medicine. Among hospitals there is a widespread belief that incorporated hospitals do not fall under this category. Says their official Journal, "The laws regulating the practice of medicine by corporations do not apply and were never intended to apply to hospitals."<sup>3</sup> No authority for the statement is cited. The Board of Trustees of the A.H.A.<sup>4</sup> is slightly contradictory when it attempts to justify corporate practice by declaring that it is not corporate practice. "The performance of diagnostic and therapeutic procedures by staff members constitutes the practice of medicine *in* hospitals. It is not the practice of medicine *by* hospitals," they say. Presumably this would be true even if such practice *in* the hospital resulted in an appreciable profit to the hospital corporation. The Board further states that, "The financial arrangement between a hospital and a physician is not a determining factor in the ethics or legality of medical practice."

The hospitals further contend that even if laws prohibiting corporate practice of medicine should apply to hospitals and if it be admitted that hospitals are actually practising medicine when they hire physicians, it is still correct to define radiology, pathology, and certain other specialties as hospital services instead of medical services. Apparently the hospitals are not too sure of their ground, else they would not find it necessary to provide three premises for the same syllogism. Hospitals which practise medicine for a profit do not practise medicine; anyway, laws prohibiting corporate practice do not apply to hospitals; and if these both be untrue, the services under question are not medical services but are hospital services.

"At what point can a line be drawn, if anywhere, between 'hospital' service and 'medical' service?" asks Michael Davis, a member of the Council of the A.H.A.,<sup>5</sup> implying that the one is the other. As a matter of fact, the question is not so difficult as it might appear. The terms are properly used—one is "hospital" and one is "medical." Numerous court decisions have defined the terms and according to Bouvier's Law Dictionary, "The primary meaning of the terms 'medical attendance' or 'medical services' is the render-

ing of professional medical services."<sup>6</sup> The Supreme Judicial Court of Massachusetts has held that, ". . . While the term 'medical services,' if used without limitation, may be susceptible of a broad construction, the statutes cited clearly indicate that those words, as therein used, are restricted to medical assistance rendered by the physician or under his direction and control."<sup>7</sup>

Physicians have delegated certain medical functions to be performed by nurses, interns, and other employees of the hospital under their direction, but these functions are performed by the hospital corporation through the sufferance and under the authority of physicians. It does not confer upon hospitals the right to indulge in the practice of medicine by themselves in disregard of the preference of physicians.

It is likewise true that the courts are well agreed that corporations cannot practise medicine and that this applies to hospital corporations. In *Granger v. Adson*<sup>8</sup> the Minnesota Supreme Court reasoned that inasmuch as a corporation or a layman could not practise law by employing a licensed attorney, for the profit of the corporation or layman employing him, to act as attorney or counsel for others, it was improper and contrary to statute and public policy for a corporation or layman to practise medicine in a similar way. Similar decisions have been rendered by courts in many other States.

When the editors of the Journal of the A.H.A. make the statement that, "The laws regulating the practice of medicine by corporations do not apply and were never intended to apply to hospitals,"<sup>9</sup> they are on unsound ground. This and a number of other statements emanating from hospital headquarters are rather convincingly refuted in a recent opinion by Judge J. F. Bouchelle, of West Virginia.<sup>10</sup> After citing considerable authority to support his opinion that a hospital corporation could not practise medicine, the Court concluded by saying, "In order that there be no misunderstanding as to the scope of this opinion, attention is directed to the fact that it is not intended to preclude contracts by individuals or corporations to furnish *hospital facilities* only. . . . Neither is it intended to prevent medical attention gratuitously contrib-

<sup>3</sup> Hospitals, June, 1938, p. 65.

<sup>4</sup> In a statement adopted June 18, 1938.

<sup>5</sup> The Modern Hospital, July, 1938, p. 57.

<sup>6</sup> Baldwin's Century Edition, p. 795.

<sup>7</sup> *People v. Pierson*, 176 N. Y., 201.

<sup>8</sup> *Granger v. Adson, et al.*, Minn. 250 N. W., 722.

<sup>9</sup> *Op. cit.*

<sup>10</sup> *Amick v. Staats Hospital*, in the Circuit Court of Kanawhat County, W. Va.

uted by doctors and surgeons to patients of incorporated charitable organizations."

For reasons of brevity it is impossible to quote the many court decisions or the statutory law bearing upon all the points raised in recent official statements by organized hospitals. It is sufficient to say that there is ample authority to disprove many of their contentions, granting at the same time that the courts are by no means completely agreed on some points.

By a rather vitriolic exception to certain principles adopted at the San Francisco session of the American Medical Association, organized hospitals have clearly defined the issue. Organized medicine wants the practice of medicine to be left to private physicians—organized hospitals demand that hospitals be privileged to take over certain specialties to be sold at a profit by the corporation. Especially are they insistent that in hospital insurance plans they be allowed to include certain medical services as benefits along with their hospital services. Medicine denies them this right, on the grounds that it alters the professional status of the physician and is contrary to public policy.

The Philadelphia County Medical Society went to court to enjoin local hospitals from proceeding with such a plan against the expressed desires of the profession. After several days of testimony before the Master, the attorneys for the hospitals agreed to accede to the demands of the county society and the plan was changed to separate hospital and medical services. Doctors who testified made it clear that they objected, not to insurance which paid cash benefits for medical services, but to the inclusion of these services as benefits *in kind* to be offered as a part of hospitalization.

Radiologists, pathologists, anesthetists, and others whose specialties are most coveted

by the hospitals, hold to the same philosophy and ethical principles as does all organized medicine. While it is undeniably true that contractual relations between practitioners of these specialties and their hospitals have placed many of these physicians in the position of employees of the hospital corporation, the fact remains that theirs is a medical service and not a hospital service. Radiologists, for instance, have permitted hospitals to collect their fees, receiving in reimbursement a salary or commission, for the simple reason that it offered an accounting convenience. Never have they relinquished their professional rights as physicians and never have they agreed that they are performing a hospital service instead of a medical service.

Regardless of the fiscal arrangement under which a radiologist practises his profession in the hospital, he denies the hospital a right to profit from his practice or to sell his services on an annual premium basis to groups of insurance subscribers. The hospital is entitled to retain a portion of radiologic fees sufficient to repay it for its costs in maintaining a department where patients can be treated and where the doctor may treat them, but it has no moral, legal, or ethical right to demand a net profit from professional services rendered by members of the staff in the hospital.

The issue is clear. It should be discussed dispassionately and attempts at settlement should always be made in a spirit of friendly co-operation. Physicians and hospitals must work together; neither can get along without the other. That the difficulties here discussed can be settled to the mutual advantage of physician and hospital and to the advantage of the public has been repeatedly proven by experience in many localities throughout the nation.

MAC F. CAHAL  
*Executive Secretary*

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# RADIOLOGICAL SOCIETIES IN THE UNITED STATES

*Editor's Note.*—Will secretaries of societies please co-operate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—*Chairman*, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary*, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

*Los Angeles County Medical Association, Radiological Section.*—*President*, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president*, E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary*, Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer*, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

*Pacific Roentgen Club.*—At its recent Annual Meeting at Pasadena, the following officers were elected for the ensuing year: *Chairman*, Lyell C. Kinney, M.D., San Diego; *Member of the Executive Committee*, Irving S. Ingber, M.D., San Francisco; *Secretary-Treasurer*, L. Henry Garland, M.D., Suite 1739, 450 Sutter Street, San Francisco. The other members of the Executive Committee are: Lowell S. Goin, M.D., Los Angeles, and Alfred C. Siefert, M.D., Oakland.

*San Francisco Radiological Society.*—*Secretary*, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

## COLORADO

*Denver Radiological Club.*—*President*, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president*, Sanford Withers, M.D., 304 Republic Bldg.; *Secretary*, Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer*, H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—*Chairman*, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Vice-chairman*, Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer*, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

## DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

## FLORIDA

*Florida State Radiological Society.*—*President*, H. O. Brown, M.D., 404 First National Bank Bldg.,

Tampa; *Vice-president*, H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer*, J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

## GEORGIA

*Georgia Radiological Society.*—*President*, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president*, William F. Lake, M.D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer*, Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

## ILLINOIS

*Chicago Roentgen Society.*—*President*, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president*, Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer*, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

*Illinois Radiological Society.*—*President*, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president*, Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer*, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

*Illinois State Medical Society, Section of Radiology.*—*President*, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa; *Secretary*, Ralph G. Willy, M.D., 1138 N. Leavitt St., Chicago.

## INDIANA

*Indiana Roentgen Society.*—*President*, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect*, Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president*, A. C. Holley, M.D., Attica; *Secretary-Treasurer*, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## MAINE

See New England Roentgen Ray Society.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—*Chairman*, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary*, H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

## MASSACHUSETTS

See New England Roentgen Ray Society.

## MICHIGAN

*Detroit X-ray and Radium Society.*—*President*, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president*,

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

*Michigan Association of Roentgenologists.*—*President*, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

MINNESOTA

*Minnesota Radiological Society.*—*President*, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

MISSOURI

*The Kansas City Radiological Society.*—*President*, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—*President*, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

*Nebraska Radiological Society.*—*President*, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

*Radiological Society of New Jersey.*—*President*, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

*Brooklyn Roentgen Society.*—*President*, Albert Voltz, M.D., 115-120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.,

Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

*Buffalo Radiological Society.*—*President*, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

*Central New York Roentgen-ray Society.*—*President*, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

*Long Island Radiological Society.*—*President*, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—*President*, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

*Rochester Roentgen-ray Society.*—*Chairman*, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

*Society of Radiological Economics of New York.*—*President*, Albert L. Voltz, M.D., 115-120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

*Radiological Society of North Carolina.*—*President*, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

## OHIO

*Cleveland Radiological Society.*—*President*, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president*, John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; *Secretary-Treasurer*, Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—*President*, B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—*President*, Charles S. Caldwell, M.D., 520 S. Aiken, Ave., Pittsburgh; *First Vice-president*, Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president*, Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer*, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor*, William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

*Philadelphia Roentgen Ray Society.*—*President*, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president*, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary*, Barton H. Young, M.D., Temple University Hospital; *Treasurer*, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

*The Pittsburgh Roentgen Society.*—*President*, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary*, Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

## RHODE ISLAND

See New England Roentgen Ray Society.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—*President*, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer*, Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## SOUTH DAKOTA

Meets with Minnesota Radiological Society

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee State Radiological Society.*—*President*, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president*, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—*President*, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect*, Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president*, C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president*, M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer*, G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

## VERMONT

See New England Roentgen Ray Society.

## VIRGINIA

*Radiological Society of Virginia.*—*President*, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

## WASHINGTON

*Washington State Radiological Society.*—*President*, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—*Secretary*, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

*Radiological Section of the Wisconsin State Medical Society.*—*Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.



# EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

## AN OPPORTUNITY FOR ROENTGENOLOGY

The avowed intention of many endowments is to achieve some advancement in knowledge that will bring benefit to humanity. Men of experience realize the shortcomings of prevalent methods and decide to devote their money and their efforts to correction of faults apparent to them. Again, some personal experience magnifies the inadequacies of existing knowledge in some specific instance and persons of means are brought to realize the possibilities of benefit inherent in research and they decide to devote their wealth to support of the efforts of trained workers, under proper supervision, toward the development of new facts and new practical experiences along these lines. The participation of established governmental services in many phases of research and practice seems to offer an opportunity which merits attention.

Even men of wide experience encounter some forms of disease so rarely that constant review of the available literature is necessary to recognition of these diseases when they present themselves. This is particularly true in roentgenology. Practical experience has demonstrated that there is a woeful lack of knowledge of the roentgenographic image of even some of the more common lesions in which the roentgenographic image is all but pathognomonic. Occasionally cases are encountered in which amputation or another drastic surgical procedure has been advised for a benign lesion and occasionally, with the best intentions but erroneously, therapeutic measures have been instituted which were not only useless but in some cases were opposed to the best interests of the patient. Heretofore these errors were discovered only at necropsy, or by study of tissue after surgical procedures had been carried out. With the advent of the roentgenogram and its factual evidence, many of these catastrophes have been averted.

Knowledge of the roentgenographic image

comes from visualization. The fault of most of the roentgenologic literature is its paucity of illustrations. The plea of the earnest student of roentgenology is for opportunity to study the roentgenographic image at the time of his reading of the literature. When this can be accomplished, roentgenology will rise to even greater heights than it has attained and will continue to be more and more respected as a diagnostic procedure. The opportunity to achieve this association of reading and illustration lies in the development of photography as an adjunct. The reduction of all manner of records, newspapers, magazines, books and so forth to 16 and 35 mm. film for the conservation of space is an accomplished fact. Provision has been made for the projection of these miniature copies under conditions that make review of them convenient, pleasant, and satisfactory in every sense.

The time seems opportune to suggest the establishment of a film library in the National Capitol, as an integral part of the Army Medical Library. With minimal requirement of space, a thoroughly comprehensive library of film studies, with the necessary apparatus for projection of them in an enlarged image, could be situated so that the literature could be consulted at the time of review of the films.

If the success of the initial experiment warranted, at small additional expense branch libraries could be established at convenient centers throughout the nation, preferably in the libraries of universities, by reproducing the master films and distributing these after they had been properly edited and legends had been written. Under proper auspices, there is no doubt that the leading institutions of the country would co-operate in allowing a survey of their material and reproduction of that chosen as suitable for incorporation in a national institution.

I believe such an object is worthy of the best

efforts of the roentgenologists as a group. Its accomplishment would mean a great deal to the men of lesser opportunity in our profession who are earnestly striving to better their

knowledge of the science of roentgenology and it would serve to heighten materially the value of roentgenology as a diagnostic procedure.

CHARLES G. SUTHERLAND, M.D.

## ANNUAL MEETING, NOV. 28—DEC. 2, 1938

### YOU'LL BE SURPRISED AT PITTSBURGH!

Have you ever really seen Pittsburgh? Are you one of the visitors who smilingly refers to the "smoky city," or have you ever seriously considered the greatness that is truly ours? While you are here we want you to take time to see our city and a few of our many unusual attractions. We promise you that you'll not be sorry. You will be surprised!

Let us take you for a brief trip to just a few of the many fascinating places our city offers to every visitor. We'll start at the lower end of the triangle in the downtown section and visit the famous Block House, located almost at the Point, where the Allegheny and Monongahela rivers join to form the mighty Ohio. And, rich in the historical lore of our great country, here stands an old brick building—all that remains of Fort Pitt.

Leaving the Block House, we drive through the Golden Triangle, one of the richest business centers in the world and the location of the home and branch offices of internationally prominent business organizations. At the outer edge of the triangle we drive up the Boulevard of the Allies, dedicated at the close of the World War and named accordingly. Travelling right on a ramp, we cross the famous Liberty Bridge and enter the Liberty Tubes, second largest vehicular tunnels in the world. After a brief trip through some of the most beautiful residential districts you will ever see, we return through the tubes to the boulevard and drive on to Schenley Park, which is only one of the twenty parks located in Pittsburgh. Leaving the park we arrive at Phipps Conservatory, the largest of its kind in the world, and something you should not miss while you are here. In this huge glass house you will find a veritable fairyland of beauty.

At this point we believe the visitor will lift an eyebrow at this new and unknown approach to a city which for so many years has retained its prominence through an industrial background alone. But, now comes the real sur-

prise: Leaving the Phipps Conservatory we approach the great Civic Center of the Oak and district, a collection of buildings and institutions which we think you will agree is unexcelled in any city in America. Our first view, of course, will be the magnificent "Cathedral of Learning," forty-two stories of schoolhouse, Gothic in architecture. You will be amazed at its beauty, inside and out. On the Forbes Street side of the great Cathedral will be found the Stephen Collins Foster Memorial, which contains the original manuscripts of this great writer of American folk songs, and stands for all to see as the costliest and finest tribute ever built to the memory of any musician. To the right of the Cathedral stands the Heinz Memorial Chapel, a religious inspiration.

Across the street from the Cathedral stands the great Carnegie Museum and Library. Whole days might be spent inspecting the unusual collections and museum pieces in these great buildings. Here, too, can be found the Carnegie Institute, always with an art exhibition of outstanding interest, and here in the winter of each year hangs the only Annual International Art Exhibit in the world. Leaving the museum and art institute, we cross the street again to the magnificent building of the Board of Education, past the Y. M. H. A. Building, and again we feel sure our visitors will gasp at the beauty and immensity, combined with graceful proportions of the Mellon Institute of Industrial Research. Here in this great "Temple of Science," which truly appears as a Greek temple, are conducted experiments which are aimed at easing man's burden. You will find experiments being conducted here at which you will marvel and thrill.

We are stopping now to leave the remainder of the inspection of our city to your own devices. We feel that you have seen a part of our Pittsburgh you didn't know. There are many more things which you will find of the keenest interest, and we hope that we have created a desire for you to come to Pittsburgh and be surprised!

# PRELIMINARY PROGRAM

## SCIENTIFIC PROGRAM of the RADIOLOGICAL SOCIETY OF NORTH AMERICA

November 28–December 2, 1938

Hotel William Penn, Pittsburgh, Penna.

*Monday Morning, Nov. 28, 1938*  
*Urban Ball Room*

10:30 A.M.

Call to order. . . . . HOWARD P. DOUB, M.D.  
President of the Radiological Society of North  
America

### SCIENTIFIC SESSION

"The Bone Changes in Primary Hypogonadism." L. M. HURXTHAL, M.D., Boston, Mass. (by invitation), and HUGH HARE, M.D., Boston, Mass.

"Bone Changes in Generalized Lipoid Diseases." MARCY L. SUSSMAN, M.S., M.D., Mount Sinai Hospital, New York City (by invitation). and L. JACHES, M.D., Mount Sinai Hospital, New York City.

"Osteogenesis Imperfecta Tarda." J. FLETCHER LUTZ, M.D., Department of Radiology and Pathology, York Hospital, York, Penna., and LEWIS C. PUSCH, M.D., Department of Radiology and Pathology, York Hospital, York, Penna. (by invitation).

### *Monday Afternoon*

2:00 P.M. Diagnostic Symposium, Section A,  
*Urban Ball Room*

Symposium on Gastro-intestinal Diseases,  
arranged by JOSEPH C. BELL, M.D., Louisville,  
Kentucky

"Experiences with the Compression Technic in Gastro-intestinal Examinations." ROSS M. GOLDEN, M.D., New York City, and PAUL SWENSON, M.D., New York City.

"Some Examples of the Use of Compression Technic in the Diagnosis of Diseases of the Upper Gastro-intestinal Tract." JOSEPH C. BELL, M.D., Louisville, Ky.

"The Roentgen-ray Diagnosis of Some Lesions of the Fundus of the Stomach." ALEXANDER B. MOORE, M.D., Washington, D. C.

"The Roentgenologic Diagnosis of Lesions of the Sigmoid and Rectosigmoid." HARRY

M. WEBER, M.D., Mayo Clinic, Rochester, Minn.

2:00 P.M. Therapeutic Symposium, Section B,  
*Cardinal Room*

Symposium on Carcinoma of the Breast,  
arranged by ROLLIN H. STEVENS, M.D.,  
Detroit, Mich.

"Evaluation of Roentgenographic Findings in the Diagnosis of Mammary Diseases." HOWARD B. HUNT, M.D., N. F. HICKEN, M.D., and T. T. HARRIS, M.D., Department of Radiology, College of Medicine, University of Nebraska, Omaha, Nebr. To be presented by Dr. Hunt.

"Carcinoma of the Breast, with Consideration of Whole Organ Section Studies." EUGENE R. WHITMORE, M.D., Department of Radiology and Pathology, Gallinger Hospital, Washington, D. C. (by invitation).

"The Relation of Ovarian Hormones to Benign Breast Hyperplasia and Neoplasia." MILTON FRIEDMAN, M.D., New York City.

"Pre-operative Treatment of Carcinoma of the Breast." FRANK E. ADAIR, M.D., Memorial Hospital, New York City (by invitation).

"Hormonal Relations of the Human Breast." CHARLES F. GESCHICKTER, M.D., Baltimore, Md. (by invitation).

4:30 P.M. Clinics.

### *Monday Evening*

7:00 P.M. Counselors' Dinner, *Urban Ball Room*

*Tuesday Morning, Nov. 29, 1938*  
*Urban Ball Room*

9:00 A.M.

"Professional Standards in Radiology." LOWELL S. GOIN, M.D., Los Angeles, Calif.

"Practical Roentgen Pelvimetry." ALBERT M. MALONEY, M.D., Boston, Mass. (by invitation).

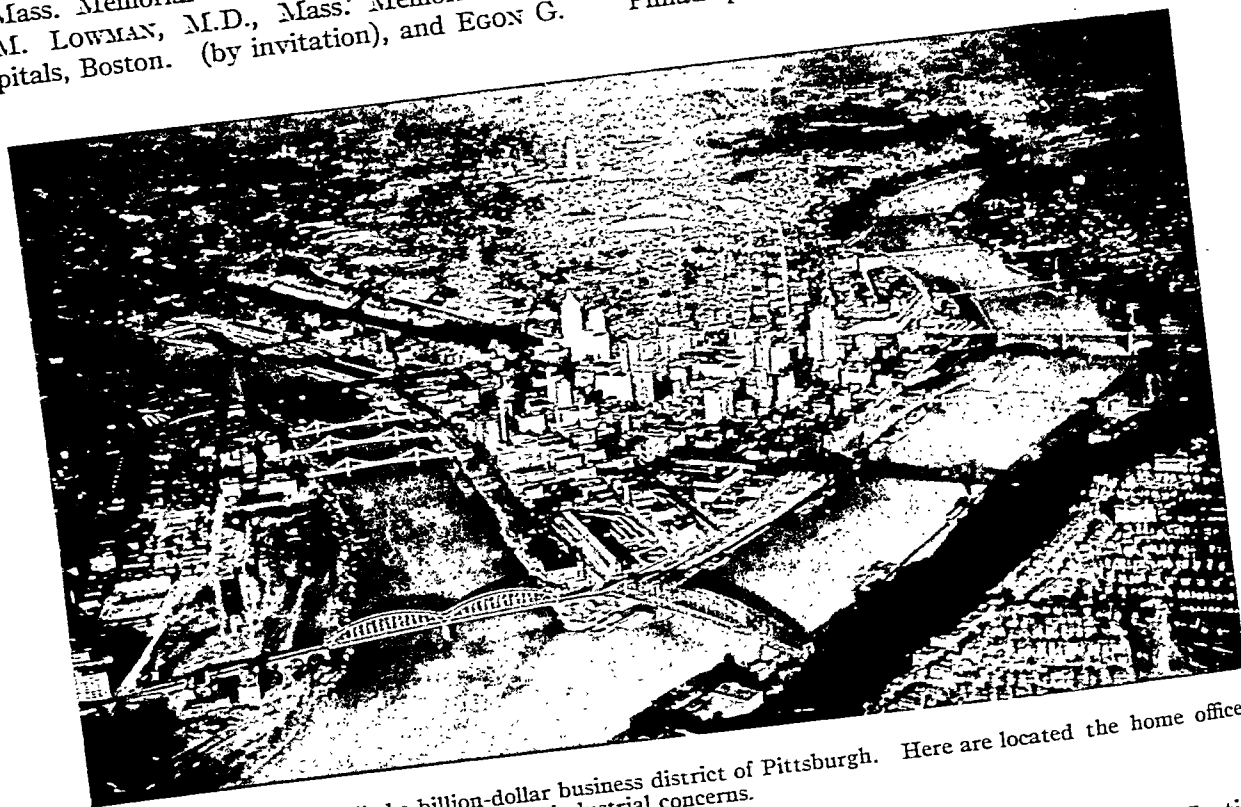
"The Roentgen Kymogram of the Heart as a Complete Record." I. SETH HIRSCH, M.D., New York City.

"The Pulmonary Arteries: A Roentgenographic and Roentgen Kymographic Study." SAMUEL BROWN, M.D., Cincinnati, Ohio; JUSTIN E. MCCARTHY, M.D., Cincinnati, Ohio, and ARCHIE FINE, M.D., Cincinnati, Ohio (by invitation).

"Roentgen Diagnosis of the Strawberry Gallbladder." GEORGE LEVENE, M.D.,

Mass. Memorial Hospitals, Boston, ROBERT M. LOWMAN, M.D., Mass. Memorial Hospitals, Boston. (by invitation), and EGON G.

Postmortem Findings in Diseases of the Lungs." JOHN T. FARRELL, JR., M.D., Philadelphia, Penna.



"The Golden Triangle," the billion-dollar business district of Pittsburgh. Here are located the home offices of some of the world's largest business and industrial concerns.

WISSING, M.D., Mass. Memorial Hospitals, Boston, Mass. (by invitation).

"The Value of Roentgen Examination of the Paranasal Sinuses." VINCENT C. JOHNSON, M.D., University of Michigan, Ann Arbor, Mich. (by invitation).

#### *Tuesday Afternoon*

2:00 P.M.

#### *EXECUTIVE SESSION*

*Urban Ball Room*

3:00 P.M. Diagnostic Symposium, Section A,  
*Urban Ball Room*

Symposium on Pulmonary Diseases, arranged by JOHN T. FARRELL, JR., M.D., Philadelphia, Penna.

"Group X-ray Surveys of Apparently Healthy Individuals." DAVID E. EHRLICH, M.D., New York City, and ARTHUR B. ROBINS, M.D., New York City (by invitation).

"Tuberculosis of the Lower Lobes." MARTIN J. SOKOLOFF, M.D., Philadelphia, Penna. (by invitation).

"Comparative Study of Roentgen and

2:00 P.M. Therapeutic Symposium, Section B, *Cardinal Room*

Symposium on Cancer of the Cervix, arranged by EDWIN C. ERNST, M.D., St. Louis, Mo.

"Roentgen Therapy." EDWIN C. ERNST, M.D., St. Louis, Mo.

"Radium Therapy." AXEL NORMAN ARNESON, M.D., St. Louis, Mo.

"Clinico-pathological Considerations." WILLIAM P. HEALY, M.D., Memorial Hospital, New York City (by invitation).

4:30 P.M. Clinics.

#### *Tuesday Evening*

CARMAN LECTURE

*Urban Ball Room*

8:30 P.M.

*Wednesday Morning, Nov. 30, 1938*  
*Urban Ball Room*

9:00 A.M.

"The Occurrence of Two or More Primary Malignant Lesions." JOHN J. COLLINS, M.D.,



"Cathedral of Learning," main building of the University of Pittsburgh. The world's only skyscraper schoolhouse.

The John D. Archbold Memorial Hospital, Thomasville, Ga.

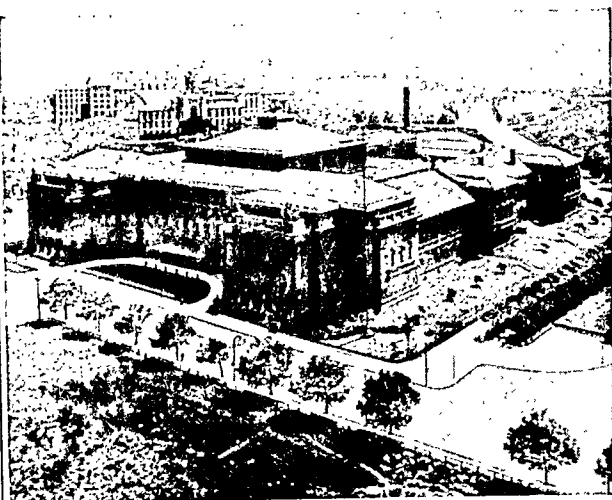
"Hyperthyroidism with Other of the Ductless Glands as Trigger Mechanisms." WARNER JENKINS, M.D., Waco, Texas (by invitation).

"The Treatment of Acute and Chronic Inflammatory Conditions by Fractional Doses of X-ray." HERMAN A. OSGOOD, M.D., Boston, Mass. (by invitation).

"Recovery Following Human Ovarian Irradiation." HAROLD W. JACOX, M.D., The Western Pennsylvania Hospital, Pittsburgh, Penna.

"Roentgen Therapy of Cancer by the Contact or Short-distance Method." GEORGE T. PACK, M.D., New York City; JAMES S. GALLO, M.D., New York City (by invitation), and BOYD E. WILKINSON, M.D., Paterson, N. J.

"Some Experiences, Experimental and Clinical, with Direct Irradiation of Neurological Tumors, at Operation with Low Voltage Radiation: A Preliminary Report." JOHN RUSSELL CARTY, M.D., New York Hospital, New



The Carnegie Institute, showing Carnegie Institute of Technology in the left background, located in Schenley Park. It comprises a department of fine arts, a museum of natural history, and a music hall.

York City, and BRONSON S. RAY, Assistant Attending Surgeon, New York Hospital, New York City (by invitation).

### *Wednesday Afternoon*

2:00 P.M. Diagnostic Symposium, Section A, *Urban Ball Room*

Symposium on Low Back and Sciatic Pain, arranged by JOHN D. CAMP, M.D., Mayo Clinic, Rochester, Minn.

"Clinical and Neurologic Aspects." M. N. WALSH, M.D., Mayo Clinic, Rochester, Minn. (by invitation).

"Orthopedic Aspects." PAUL B. STEELE, M.D., Pittsburgh, Penna. (by invitation).

"Significant Skeletal Changes (Roentgenologic Observations)." RALPH S. BROMER, M.D., Bryn Mawr, Penna.

"Air Myelography: The Use of Air as the Contrast Medium in Roentgen Exploration of the Spinal Canal." W. EDWARD CHAMBERLAIN, M.D., Philadelphia, Penna., and BARTON R. YOUNG, M.D., Philadelphia, Penna. (by invitation).

"Experiences with Lipiodol in the Localization of Lesions Associated with Low Back and Sciatic Pain." JOHN D. CAMP, M.D., Mayo Clinic, Rochester, Minn.

2:00 P.M. Therapeutic Symposium, Section B, *Cardinal Room*

Symposium on Radiotherapy for Inflammatory Conditions, arranged by ARTHUR U. DESJARDINS, M.D., Mayo Clinic (Section on Therapeutic Radiology), Rochester, Minn.

"Acute Otitis Media." ANDREW H. DOWDY, M.D., Strong Memorial Hospital, Rochester, N. Y. (by invitation), and CLYDE HEATLY, M.D., Strong Memorial Hospital, Rochester, N. Y. (by invitation).

"The Roentgen Therapy of Carefully Selected Sinus Infections." FRED M. HODGES, M.D., Richmond, Va., and L. O. SNEAD, M.D., Richmond, Va. (by invitation).

"The Use of the Mobile X-ray Unit in the Treatment of Peritonitis, Gas Gangrene, and Other Inflammatory Processes at the Bed-side." JAMES F. KELLY, M.D., Omaha, Nebr.

"Further Experiences with Roentgen Therapy for Bronchiectasis." MAURICE BERCK, M.D., New York City (by invitation), and WILLIAM HARRIS, M.D., New York City.

"Roentgen Therapy for Chronic Infectious Arthritis." ARTHUR U. DESJARDINS, M.D., Mayo Clinic, Rochester, Minn.

4:30 P.M. Clinics.

*Thursday Morning, Dec. 1, 1938*  
*Urban Ball Room*

9:00 A.M.

"A Roentgenologic Consideration of Gastritis." MAURICE FELDMAN, M.D., Assistant Professor of Gastro-enterology, University of Maryland, Baltimore, Md.

"Chronic Gastric Volvulus." ARTHUR C. SINGLETON, M.D., Toronto, Ontario, Canada.

"Benign Duodeno-colic Fistula, with Report of Two Cases." CLARENCE N. McPEAK, M.D., Fitchburg, Mass. (by invitation).

"Polyps of the Large Bowel." EDWARD L. JENKINSON, M.D., St. Luke's Hospital, Chicago, Ill., and WILLIAM WASKOW, M.D., St. Luke's Hospital, Chicago, Ill. (by invitation).

"The Incidence of Duodenal Ulcer in the Presence of a Gall-bladder Symptomatology." ERIC J. RYAN, M.D., St. Luke's Hospital, New York City.

"Roentgenological Differential Diagnosis between Diverticulitis and Cancer of the Colon." RICHARD SCHATZKI, M.D., Massachusetts General Hospital, Boston, Mass.

*Thursday Afternoon*

2:00 P.M.

EXECUTIVE SESSION

*Urban Ball Room*

3:00 P.M. Diagnostic Symposium, Section A,  
*Urban Ball Room*

Symposium on Body Section Radiography, arranged by SHERWOOD MOORE, M.D., St. Louis, Mo.

"Analysis of the Various Motions Suitable for Body Section Radiography." MR. JEAN KIEFFER, Supervisor of Laboratories, Norwich State Tuberculosis Sanatorium, Norwich, Conn. (by invitation).

"Sectional Roentgenography: Its Application to the Upper Respiratory Tract." WILLIAM E. HOWES, M.D., Brooklyn, N. Y.

"Exploration of the Thorax with Body Section Roentgenography." HUGH M. WILSON, M.D., Associate Professor of Radiology, Yale University School of Medicine, New Haven, Conn. (by invitation).

"Body Section Radiography." SHERWOOD MOORE, M.D., Professor of Radiology, Washington University School of Medicine and Director of the Edward Mallinckrodt Institute of Radiology, St. Louis, Mo.

2:00 P.M. Therapeutic Symposium, Section B, *Cardinal Room*

Symposium on The Treatment of Carcinoma of the Pharynx and Larynx, arranged by L. HENRY GARLAND, M.D., San Francisco, Calif.

"Present Conception of Treatment of Carcinoma of the Larynx." HENRI COUTARD, M.D., Chicago (by invitation).

"Surgical Treatment of Cancer of the Larynx." J. HOMER MCCREADY, M.D., Pittsburgh, Penna. (by invitation).

"Technic and Complications of Treatment of Carcinoma of the Pharynx." HAYES E. MARTIN, M.D., New York City.

4:30 P.M. Clinics.

7:00 P.M.

BANQUET

*Urban Ball Room*

*Friday Morning, Dec. 2, 1938*  
*Urban Ball Room*

9:00 A.M.

"The Density of the Central Shadow of the Thorax in the Diagnosis of Intrathoracic Lesions." LEO G. RIGLER, M.D., Minneapolis, Minn.

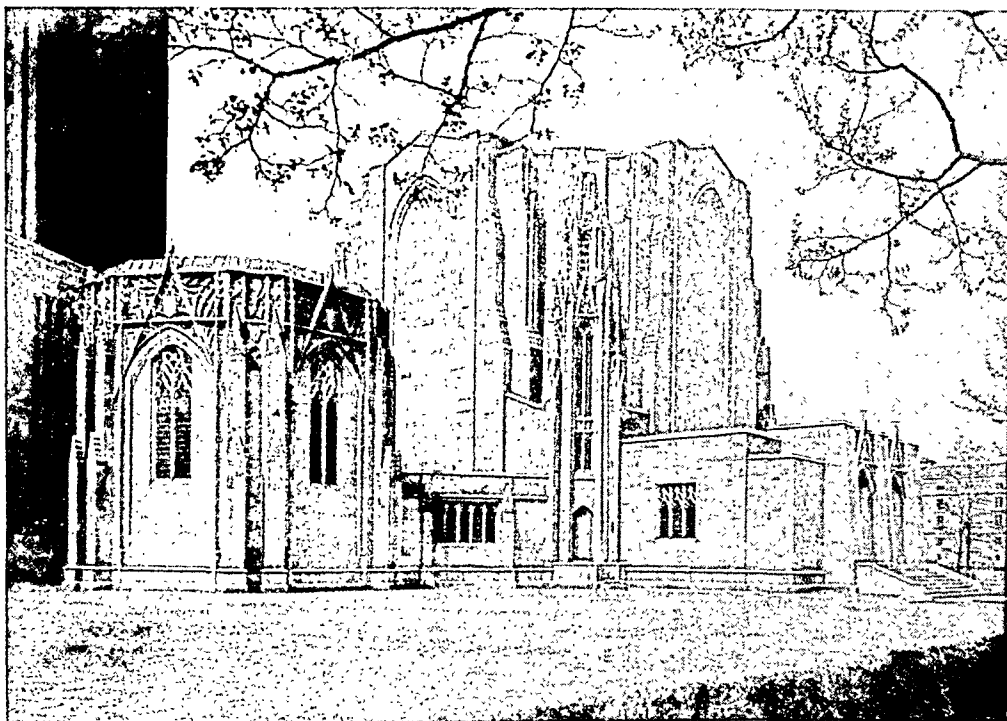
"Pulmonary Involvement in the Lymphoblastomas: Special Reference to Roentgen Aspects." ADOLPH HARTUNG, M.D., University of Illinois, Chicago.

"X-ray Intensity Meter." ROBERT B. TAFT, M.D., Charleston, S. C.

"Problems in Roentgen Diagnosis of Pulmonary Tuberculosis." CARL C. BIRKELO, M.D., Detroit, Mich., and W. L. BROSIUS, M.D., Herman Kiefer Hospital, Detroit, Mich. (by invitation).

Symposium on Industrial Diseases, arranged by ELDWIN R. WITWER, M.D., Detroit, Mich. (*Tentative Titles*)

"Silicosis." EUGENE P. PENDERGRASS, M.D., Philadelphia, Penna.



Stephen Collins Foster Memorial Theater and Shrine, finest building ever dedicated to a musician; a fitting tribute honoring "America's Troubadour," born at Pittsburgh July 4, 1826.

"Castration of the Female by Irradiation: The Results in 335 Patients":

Part A, "An Efficient Radiological Technique." WILLIS S. PECK, M.D., and JOHN T. MCGREER, M.D., Department of Roentgenology, University of Michigan, Ann Arbor, Mich. (by invitation).

Part B, "Menopausal Symptoms." NORMAN KRETZCHMAR, M.D., and WILLIS BROWN, M.D., Department of Gynecology and Obstetrics, University of Michigan, Ann Arbor, Mich. (by invitation).

"Recent Advances in Nuclear Physics." DR. E. V. CONDON, Westinghouse Research Company, East Pittsburgh, Penna. (by invitation).

#### *Friday Afternoon*

2:00 P.M. Diagnostic Symposium, Section A, Urban Ball Room

"Silico-tuberculosis." BRUCE DOUGLAS, M.D., Detroit, Mich. (by invitation).

"Asbestosis." RALPH D. LEONARD, M.D., Boston, Mass. (by invitation).

"The Influence of Gases on Pulmonary Tissues." DR. E. E. EVANS, DuPont Film Corporation, New York City (by invitation).

2:00 P.M. Therapeutic Symposium, Section B, Cardinal Room

Symposium on What are the Differences Between 200 kv. and Supervoltage Roentgen-therapy, arranged by U. V. PORTMANN, M.D., Cleveland Clinic Foundation, Cleveland O.

"The Physical Aspects." RICHARD DRESSER, M.D., and Associates, Boston, Mass., and KENNETH E. CORRIGAN, PH.D., Detroit, Mich. (by invitation).

"The Biological Aspects." CHARLES

PACKARD, M.D., New York City (by invitation).

"The Chemical Aspects." WILLIAM E.

COSTOLOW, M.D., Los Angeles, Calif., and

HENRY SCHMITZ, M.D., Chicago.

### CLINICS

To be held afternoons, except Friday, from four-thirty to five-thirty o'clock.

#### AUTHORS

SHERWOOD MOORE, M.D.

JOHN D. CAMP, M.D.

EUGENE P. PENDERGRASS, M.D.

JOSEPH C. BELL, M.D.

JOHN R. CARTY, M.D.

MRS. EDITH H. QUIMBY

BERNARD P. WIDMANN, M.D.

#### TITLES

"Body Section Radiography"

"The Use of Iodized Oil in the Location of Lesions within the Spinal Canal"

"Silicosis"

"The Use of the Spot Film in the Diagnosis of Lesions of the Gastro-intestinal Tract and Gall Bladder"

"Diagnostic Possibilities of Radiography of the Soft Tissues"

"Specification of Tissue Dosage in Radiotherapy"

"Irradiation of Superficial Cancer with Low Voltage Roentgen Rays"

Complete information concerning the above clinics will be published at a later date.

### REFRESHER COURSES

The first annual "Refresher Series," post-graduate course, sponsored by the Radiological Society of North America, will be held at Pittsburgh, Penna., November 27 and 28, 1938. The following is a brief description of the Courses:

#### PHYSICS OF RADIATION

J. L. WEATHERWAX, M.A.

EDITH H. QUIMBY, M.A.

Characteristics of roentgen radiation. Dosimetry, isodose curves, depth dose charts. Classification technics. Definition of dosage. Recovery rates. Characteristics of radiation from radium or radon. Data concerning transmission by various filters, dosimetry, management of radiation. Biological effect of irradiation. Radiosensitivity, theories of radiation reaction, protective measures. Typical roentgen and radium therapy technics, factors to be considered. Records.

#### RADIOLOGY OF THE CHEST

WALTER W. WASSON, M.D.

(1) Anatomy of the lungs with corrosive specimens demonstrating the bronchi and their air cells and the arteries and veins. (2) Anatomy of the lungs and thorax as portrayed by

the roentgen film. (3) A discussion of the physiology of the lungs and mechanics of the thorax, particularly as it pertains to roentgenology. (4) Diseases of the chest and particularly of the lungs with a discussion of their classification, portrayal, and diagnosis. (5) Radiation therapy of the thorax and especially a discussion of its hazards.

#### RADIOLOGY OF THE GASTRO-INTESTINAL TRACT

E. P. PENDERGRASS, M.D.

The course is planned to cover physiology of the gastro-intestinal tract, roentgenology of the gastro-intestinal tract, and physiology of the gall bladder in both formal and open forum discussion. Tentatively, the presentation will consist of a discussion of the physiology of the gastro-intestinal tract for one and one-half hours by Dr. Abbott, following which, one and one-half hours will be devoted to the roentgen examination of the esophagus, stomach, and small intestine by Dr. Pendergrass. Roentgenology of the colon will be covered by Dr. Gershon-Cohen at the fourth hour. Physiology of the gall bladder will be discussed by Dr. Ravdin during the fifth hour and the roentgenological aspect of the gall bladder by Dr. Pendergrass during the sixth hour.



## PATHOLOGY OF TUMORS

W. CARPENTER MACCARTY, M.D.

(1) Brief historical sketch of the evolution of pathology, pathologists and radiologists, and the relation of each to the other and to clinical medicine. (2) Fundamentals underlying disease, the thing called inflammation and its relation to x-ray diagnosis and treatment. (3) Fundamentals of the evolution of neoplastic conditions, their physical and clinical characteristics, and their relation to x-ray diagnosis and radiological treatment.

(1) The language of disease. (2) Clinical and radiological classification of inflammatory and neoplastic disease. (3) Practical bio-pathological, physical, and radiological classification of disease. (4) Difficulties of examining boards and those examined. (5) Suggestions for review. (There will be a ten minute recess between each subject.)

## RADIOLOGY OF BONE TUMORS

J. T. MURPHY, M.D.

A course on radiology of bone tumors which is to be conducted as a clinical-pathological conference with Dr. Plinn F. Morse. The course is designed to emphasize differential diagnosis and treatment. The field of bone tumors is to be tersely classified and illustrated examples of each class presented.

## ROENTGEN ANALYSIS OF FRACTURES

W. EDWARD CHAMBERLAIN, M.D.

Roentgen analysis of fractures will be presented systematically; apparatus will be employed to illustrate certain features. Fluoroscopic methods will be demonstrated and the many ingenious and helpful plans for the analysis and handling of fracture problems will be shown.

## RADIOLOGY OF SINUSES AND MASTOIDS

GEORGE W. GRIER, M.D.

Anatomy of sinuses and mastoids. Technical considerations in the production of radiographs of sinuses and mastoids; the author's plan of examination. Pathology of diseases affecting sinuses and mastoids. Roentgen interpretation; correlation of roentgen findings and pathologies. Radiation therapy of sinuses and mastoids.

The Executive Committee has ruled that no charge shall be made for enrollment. Rooms available require the limitation to sixty in each course. Enrollment return cards will be mailed

to all members one month before the date of the Annual Meeting. Members of the Radiological Society will be given preference and enrolled in the order in which the cards are received. Only sixty will be enrolled in each course.

## COMMUNICATION

## MIDSUMMER RADIOLOGICAL CONFERENCE

The Fourth Midsummer Radiological Conference in the Rocky Mountains, sponsored by the Denver Radiological Club, was held Aug. 11, 12, and 13, 1938. The guest speakers were: Wendell G. Scott, A.B., M.D.; Lowell S. Goin, M.D., F.A.C.R.; Orville Meland, M.D., F.A.C.S.; B. R. Kirklin, M.D., F.A.C.R.; Ralph E. Herendeen, M.D.; R. R. Newell, M.D.; Daniel T. Quigley, M.D., F.A.C.R., and Ernst A. Pohle, M.D., Ph.D., F.A.C.R.

The following papers were read by their authors: "The Diagnosis of Thoracic Diseases Other than Tuberculosis," Wendell G. Scott, M.D., Saint Louis; "The Classification, Recognition, and Differentiation of Bone Tumors," Lowell S. Goin, M.D., F.A.C.R., Los Angeles; "Irradiation Therapy of Bone Tumors," Orville Meland, M.D., F.A.C.S., Los Angeles (discussion by Ralph E. Herendeen, M.D., New York City); "Clinical Indications for Roentgenologic Examination of the Gastro-intestinal Tract" (Samuel B. Childs Lecture), B. R. Kirklin, M.D., F.A.C.R., Rochester, Minn.; "Developments in the Practice of Radiology, with Special Reference to Roentgen Therapy" (Sanford Withers Lecture), Ralph E. Herendeen, M.D., New York City; "The Roentgenological Aspect of Collapse Therapy in Pulmonary Disease," Ernst A. Schmidt, M.D., Denver; "The Joint Changes in Hemophilia," Nathan B. Newcomer, M.D., Denver; "Fractures and Pseudo-fractures of the Sutures of the Skull," Frank B. Stephenson, M.D., Denver; "Pulmonary Infarction," Lowell S. Goin, M.D., Los Angeles; "The Radiological Diagnosis of Heart Disease, with Special Reference to Roentgen Kymography," Wendell G. Scott, M.D., Saint Louis; "Roentgenologic Studies of the Stomach and Duodenum Following Operation," B. R. Kirklin, M.D., F.A.C.R., Rochester, Minn.; "Arthritis," Kenneth D. A. Allen, M.D.,

Denver; "Errors in the Diagnosis of Spondylolisthesis," W. W. Wasson, M.D., Joseph Connell, M.D., and G. E. Sanford, M.D., Denver; "Quality of Roentgen Ray: Physical Aspects," R. R. Newell, M.D., San Francisco; "Etiological Factors in Some Forms of Cancer," Daniel T. Quigley, M.D., Omaha; "Radiation Therapy of Leukemia, Hodgkin's Granuloma, and Allied Diseases," Ernst A. Pohle, M.D., Madison, Wisc.; "Advances in Radiation Therapy," Paul R. Weeks, M.D., Denver; "Irradiation Therapy in the Treatment of Mixed-cell Tumor of the Parotid," Edward J. Meister, M.D., Denver; "The Treatment of Carcinoma of the Breast: Technic, Complications, and Results," Elizabeth Newcomer, M.D., Denver; "Quality of Roentgen Ray: Clinical Importance," R. R. Newell, M.D., San Francisco; "Roentgen Therapy in Carcinoma of the Uterus and a New Method of Dosage," Ralph E. Herendeen, M.D., New York City; "How can the Results of Irradiation in Carcinoma of the Rectum be Improved upon?" Orville N. Meland, M.D., F.A.C.S., Los Angeles.

Scientific exhibits were shown by the following: Ralph E. Herendeen, M.D., New York City, "The Effect of Irradiation on Bone Tumors"; Wendell G. Scott, M.D., St. Louis, "Kymographic Studies of Gastro-intestinal Movements"; Ernst A. Schmidt, M.D., Denver, "Collapse Therapy in Pulmonary Disease"; H. P. Brandenburg, M.D., Denver, "Metastatic Carcinoma of Lung"; Nathan B. Newcomer, M.D., Denver, "Hemophilic Joints"; Elizabeth Newcomer, M.D., Denver, "Metastases Following Carcinoma of the Breast"; F. B. Stephenson, M.D., K. D. A. Allen, M.D., and P. R. Weeks, M.D., Denver, "Practical Consideration of Bone Tumors"; "Skull Sutures and Pseudo-fractures"; W. Walter Wasson, M.D., Denver, "Spondylolisthesis"; C. E. Skomp, M.D., Denver, "Interesting Cases of Abdominal Pathology"; Cassie Belle Rose, M.D., Boulder, Colo., "Calcification of Neoplastic Disease of Bone Resulting from Irradiation"; "Lesions of the Colon, Chiefly of the Cecum"; Leonard G. Crosby, M.D., "Diaphragmatic Hernia."

## BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**ELEMENTARY SURVEY OF PHYSICS:** A Non-mathematical Presentation with a Special Supplement for Pre-medical Students. By ARTHUR E. HAAS, PH.D., with the collaboration of IRA M. FREEMAN, PH.D. A volume of 203 pages. Published by E. P. Dutton & Company, Inc., New York City, 1938. Price: \$1.90.

**CLINICAL ROENTGENOLOGY OF THE DIGESTIVE TRACT.** By MAURICE FELDMAN, M.D., Assistant Professor of Gastro-enterology, University of Maryland, Associate Roentgenologist, Sinai Hospital, Assistant in Gastro-enterology, Mercy Hospital, Baltimore, Maryland. A textbook and reference book dealing with the clinical, surgical, and pathologic aspects of all diseases of the digestive tract. A volume of 1,010 pages, 358 illustrations, 179 tables, with references to all 220 chapters. Published by William Wood & Company, Baltimore, 1938. Price: \$10.00.

**SURFACE AND RADIOLOGICAL ANATOMY:** For Students and General Practitioners. By ARTHUR B. APPLETON, M.A., M.D. (Cantab.), Prof. of Anatomy in the University of London and Director of the Department of Anatomy in the Medical School of St. Thomas's Hospital, London, late Fellow of Downing College, Cambridge; WILLIAM J. HAMILTON, M.D., B.Ch. (Belf.), D.Sc. (Glas.), F.R.S.E., Prof. of Anatomy in the University of London at the Medical College of St. Bartholomew's Hospital, London, late Deputy Director of the Dept. of Anatomy in the Medical School of St. Thomas's Hospital, London, and IVAN C. C. TCHAPEROFF, M.A., M.D., B.Ch. (Cantab.), D.M.R.E., Asst. Radiologist of St. Thomas's Hospital, London. A volume of 311 pages, with 338 illustrations. Published by William Wood & Company, Baltimore, 1938. Price: \$5.50.

**OUTLINE OF ROENTGEN DIAGNOSIS:** An Orientation in the Basic Principles of Diagnosis by the Roentgen Method. By LEO G. RIGLER, B.S., M.B., M.D., Professor of Radiology, University of Minnesota, Minneapolis. Atlas Edition; a volume of 226 pages; 254 illustrations shown in 227 figures, presented in drawings and reproductions of roentgenograms. (Figures 6 to 51 and 55 to 72 are drawings in an original technic by Jean E. Hirsch.) Published by J. B. Lippincott Company, Philadelphia, 1938. Price: \$10.00.

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## HERNIA

A Case of Congenital Hernia of the Lung. Lerou-dier, J. L. Cousergue, and Popof. *Jour. de radiol. et d'électrol.*, 22, 23-25, January, 1938.

A case in which there was herniation of the lung into the tissues of the neck above the level of the cricoid cartilage is presented and discussed in detail.

S. R. BEATTY, M.D.

## THE HIP JOINT

The First Stages of Coxa Plana. Henning Waldenström. *Jour. Bone and Joint Surg.*, 20, 559-566, July, 1938.

The author objects to the names "Perthes' disease," "Perthes-Legg disease," and "osteochondritis deformans" for this disease and insists on the term "coxa plana."

A study of cases of this disease in its earliest form was made, the group numbering 13. The x-ray appearance of the hip joints (always including both joints) in the conventional anteroposterior projection may not show definite abnormality, but by using Lauenstein's position (femur in flexion and abduction) early changes are seen in the femoral head.

Always comparing both joints, it is found that the femoral epiphysis on the diseased side is lower and flattened on its superior aspect. This is especially marked in Lauenstein's position. About the epiphysis superiorly a thin, faint line concentric with the epiphysis is found, which is the joint cartilage to which some bone still remains unabsorbed. There is also an increase in distance between the femoral epiphysis and the bottom of the acetabulum. This space is filled with synovia. Another point demonstrated is that the curved line of the posterior rim of the acetabulum, seen through the femoral head mesially, is less in coxa plana. In all the examined cases, the distance between the epiphysis and the bottom of the acetabulum has been increased.

J. B. McANENY, M.D.

## INFECTION

An Experimental Study of the Effect of X-radiation upon Acute Pyogenic Infection of the Skin and Subcutaneous Tissues. José A. Soto, Alexander Brunswick, and F. W. Schlutz. *Surgery*, 3, 593-600, April, 1938.

The authors used 105 rabbits as controls and experimental animals. X-rays were generated at 200 kv., 25 ma., and filtered through 1.0 mm. Cu plus 1.0 mm. Al at 50 cm. distance. *B. coli* and several strains of *Staphylococcus aureus* were used to produce infections. Croton oil, histamine di-hydrochloride, and trypan blue were used to study the effect of radiation upon lymphatic spread.

The authors conclude that moderate doses of the above radiation reduce the severity of the acute pyogenic infections in the skin but do not hasten the final healing of the lesions. In some instances the irradiated lesions healed more slowly.

There is some effect if the radiation is delivered before infection, but the optimal effect is obtained if irradiated shortly after. The effect decreases as the suppurative phase of the infection becomes more prominent.

Microscopic sections show no increase in lymphocytic destruction in the irradiated areas over the control areas.

There is a slightly greater absorption of soluble substances from inflamed areas after irradiation.

J. E. WHITELEATHER, M.D.

## THE INTESTINES

Congenital Absence of Portion of the Small Intestine. John McGregor and Morris Rothenberg. *Northwest Med.*, 37, 134-136, May, 1938.

A case is reported of an apparently normal, new-born child who presented symptoms of intestinal obstruction a few hours after birth. The diagnosis was confirmed by x-ray study of the gastro-intestinal tract. Operative treatment was offered and an end-to-end anastomosis was done between two blind loops of intestine. The autopsy revealed absence of the small intestine from a point 30 inches below the ligament of Treitz, to about 29 inches proximal to the ileocecal valve.

In their comments the writers state that until 1922 only 401 such cases had been reported, and that since then only six additional cases have appeared in the literature.

A. MAYORAL, M.D.

Roentgen Diagnosis of Hepatodiaphragmatic Interposition of the Large Intestine. K. J. Kolji. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 928-936, June, 1938.

Out of 20,000 roentgenoscopies, the author observed 29 patients with hepatodiaphragmatic interposition of the large intestine. In all of the cases the finding was incidental.

The differential diagnosis roentgenologically includes an artificial or spontaneous pneumothorax and subdiaphragmatic abscess. Two types of interposition were found, a temporary and a permanent form. The first oblique position was found most suitable for showing some minor forms of interposition. Filling the intestine with contrast medium assisted in making the diagnosis in obscure cases.

IRVING I. COWAN, M.D.

Roentgenologic Studies of the Large Bowel in Infections by *Endamæba histolytica* Before, During, and After Treatment. Joseph C. Bell. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 916-924, June, 1938.

Three detailed case reports are given, with the roentgen findings. The deformity of the cecum characterized by an irregular narrowing resembling a cone, is the most constant and most characteristic change noted.

Partial Gastrectomy for Gastric or Duodenal Ulcer. Samuel F. Marshall and Everett D. Kiefer. *Jour. Am. Med. Assn.*, 109, 1341-1346, Oct. 23, 1937.

Certain clinical features have proved to be definite indications for surgical intervention in the management of patients with duodenal ulcer. It is obvious that acute perforation requires immediate surgical intervention. Patients with intractable ulcer, who for one reason or another fail to obtain relief with adequate medical care, are forced to submit to operation for control of their disease. Pyloric obstruction due to spasm, infection, or edema can be relieved by rest, diet, and alkalization. However, recurring bouts of acute ulcer produce narrowing of the pylorus, shortening of the duodenum by scar formation, and real cicatricial stenosis, which necessitates surgery. Recurrence of gross hemorrhage in spite of adherence to a regimen for ulcer is a definite indication for surgical intervention. They have established the policy of advising surgical treatment for patients with serious recurrent hemorrhage.

A large percentage of gastric ulcers will heal readily and completely with medical treatment. Surgical treatment is therefore indicated only for the gastric ulcer which, because of the large size of the crater or extension into adjacent tissues, proves intractable with medical measures and for the ulcer which, because of insufficient tendency to heal during medical management, is suspected of being an early carcinoma. Recurrent massive hemorrhage is an indication for operation. Obstruction is rarely an indication for operation in cases of benign lesion.

The greatest benefit accomplished by the surgical management of ulcers results from the change in the gastric secretory and motor function, and there is little doubt that, of all operative procedures, partial gastrectomy best accomplishes this change.

The technical difficulties of such a formidable operation as partial gastrectomy, which involves removal of at least three-fourths or four-fifths of the stomach, are considerable and are to be surmounted only by an extensive experience with gastric surgery.

CHARLES G. SUTHERLAND, M.D.

## PNEUMONIA

Lipoid Pneumonia and Oil in the Lungs. Editorial. *Jour. Am. Med. Assn.*, 109, 1367, 1368, Oct. 23, 1937.

Fatal cases of pneumonia due to aspiration of oily preparations into the lungs have been reported in the American medical literature as lipoid pneumonia since 1925. Liquid petrolatum is the chief etiologic agent. The condition is observed usually in children under 2 years, generally the result of too frequent installations of oily nose drops. The fats and oils which cause this disease reach the alveoli of the lungs, where they collect and give rise to chronic inflammatory processes resulting in fibrosis. Lipoid pneumonia of the adult type is a distinct clinicopathologic entity.

The typical pulmonary lesion represents a chronic, non-specific, non-suppurative, granulomatous foreign body leading to ultimate tumefaction and fibrosis. Patients show the clinical signs and symptoms of a low grade pneumonia. Roentgenograms usually show a shadow along the sternal border of the pulmonary fields. At necropsy the lungs show evidence of the reaction of the tissues to a foreign body and the results of secondary invasion by bacteria.

Oily nasal drops are not the only agents that may cause this form of pneumonia in infants; cod liver oil and even cream have been involved in some of the cases.

CHARLES G. SUTHERLAND, M.D.

## THE PROSTATE

The Roentgen Diagnosis of the Prostate. L. Haas and K. Fillenz. *Jour. de radiol. et d'électrol.*, 22, 103-108, March, 1938.

The use of radiographic methods in the diagnosis of prostatic disease is not as general as the value of such methods would indicate. The authors prefer the injection of dye rather than air into the bladder. Not only the size of the prostatic enlargement, but also the deformity and secondary changes (such as diverticula) in the bladder, are defined. Several illustrative cases are presented.

S. R. BEATTY, M.D.

## RADIATION BURNS AND INJURIES

Injuries to the Blood Vessels of the Heart and Their Prevention in the Protracted Fractional Treatment of Tumors of the Upper Air and Digestive Tracts. H. Bartsch and G. Wachner. *Strahlentherapie*, 1938, 62, 339.

Patients undergoing x-ray therapy over the heart region sometimes develop circulatory disturbances. The authors recommend, therefore, prophylactic digitalization in combination with caffeine medication. This prophylactic treatment has proved very valuable in their experience.

ERNST A. POHLE, M.D., Ph.D.

A New Treatment of Persistent Ulcerating Radiodermatitis: The Application of Vitamin A. H. Sobier and L. Ginieys. *Jour. de radiol. et d'électrol.*, 22, 112-114, March, 1938.

The authors discuss the various therapeutic measures which have been used in the treatment of chronic ulcerative radiodermatitis. They present a case of extensive involvement of over six and a half years' duration, previously treated with a number of agents, which responded by rapid healing when treated with cod liver oil and other sources of vitamin A.

S. R. BEATTY, M.D.

Ulceration of the Small Intestine Following Irradiation of the Pelvis: Report of Two Cases. I. A. B. Cathie. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 895-898, June, 1938.

In a series of nearly 400 cases treated for carcinoma of cervix uteri, two patients developed intractable diarrhea and died, although the roentgen dosage was well within the limits of normal tolerance. Since the lesions in the intestine were practically limited to the small intestine beyond the irradiated areas, the author believes that the changes produced were an example of severe irradiation sickness. He emphasizes the fact that all transient diarrheas should be regarded with the gravest concern.

IRVING I. COWAN, M.D.

Intestinal Injuries after Radium and Roentgen Treatment of Carcinoma of the Cervix. James A. Corscaden, Haig H. Kasabach, and Maurice Lenz. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 871-887, June, 1938.

The records of 350 cases of carcinoma of the cervix and 92 cases of carcinoma of the corpus, treated by radium, were carefully reviewed and there were 139 patients who had symptoms related to the lower alimentary system. In this group a large number developed a simple proctitis; severe inflammation was present in 16 cases; ulceration in 12 cases; cicatricial stenosis, one case; perforation, five cases; one case of obstruction by kinking of an uninjured intestine, and two cases of obstruction complicating persistent carcinoma. In all, 15 detailed case reports are given.

The anatomic findings showed that the injurious action of irradiation is selectively on the intestinal mucosa, with practically no effect on the muscular coats. The maximum injury in the majority of the cases is in the fixed portion of the lower colon, particularly at the distal end of the sigmoid. In the roentgenologic examination of the colon one must differentiate between a malignant growth of the colon, extension of the primary neoplasm from the cervix, and a post-irradiation colitis.

Radiation injuries were eliminated by reducing the number of milligrams used in the utero-vaginal application from 175 to 70 and increasing the duration of the application from 40 to 100 hours; by reducing the daily roentgen dose from 300-400 r to 100-200 r, and the size of the field from 20 × 20 cm. or 15 × 20 cm. to 10 × 15 cm. or less, and increasing the duration of the course of treatment from 21 to 30-40 or more days. Following this change in technic the incidences of intestinal injuries, which had been 8.7 per cent, dropped to nil.

IRVING I. COWAN, M.D.

Deteriorative Changes in Heredity Brought about by Irradiation. A. Pickhan. *Strahlentherapie*, 1938, 62, 240.

The author analyzed the results of a number of investigations concerning the effect of radiation on mutations. He concludes that all rays of short wave length, beginning with ultra-violet down to the gamma rays of radium, may cause changes in the mutations and gene

cells. The effect is in direct and linear proportion to the order of magnitude of the dose applied. The mutation rate is apparently independent of the wave length, and the time distribution of the dose. There is no recovery and the reaction is irreversible. From experiments on *Drosophila* eggs, he proposes a dose of 20 r as the total dose which can be applied safely to the gonads before and during their active period. Consequently, the administration of roentgen rays to human beings in the region of the generative organs both for diagnostic and therapeutic purposes must not exceed this safe dose as long as there is still a probability of pregnancy later. The fact that normal children have been born although the gonads of either parent had been exposed to higher doses of radiation does not prove the harmlessness of such exposures, because the major percentage of the mutations is recessive.

ERNST A. POHLE, M.D., Ph.D.

## THE SKULL

A Roentgenological Study of Pineal Orientation. III.—A Comparison of Methods Used in Pineal Orientation. Walter W. Fray. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 899-907, June, 1938.

The author has devised two methods of pineal orientation, one of which, the proportional method, eliminates the need of consulting charts or making direct measurements with a rule. The method consists of using an elastic cord upon which are placed markers defining the normal zones for both the long and vertical diameters of the skull. The other method, the cranio-angle method, determines displacement along the vertical diameter of the skull.

The two methods described by the author are compared with the original Vastine and Kinney method and are found to reduce the error in normal cases approximately 50 per cent for measurements along the antero-posterior diameter and 33 per cent for measurements along the vertical diameter. In proven cases of brain tumor, pineal displacement was more frequently detected by the author than by the original graphic method of Vastine and Kinney. The analysis of the type of displacement does not yield positive information regarding sharp localization in the cerebral lobes, though an analysis of the data may permit the elimination of tumors in certain regions.

IRVING I. COWAN, M.D.

Value and Difficulties of Roentgen Diagnosis in Fractures of the Middle and Posterior Fossæ of the Base of the Skull. A. P. Lachapèle. *Jour. de radiol. et d'électrol.*, 22, 1-18, January, 1938.

Fractures of the middle and posterior fossæ are often missed, frequently because symptoms directing attention to these regions are absent, and the usual roentgenographic projections are insufficient to demonstrate these parts adequately.

A complete roentgenologic examination is necessary in all cranial traumatism and will often reveal surprises.

Such an examination should follow strict rules of technique and completeness. It should include views in the four main planes (postero-anterior, lateral, vertical, and fronto-occipital) and special views of certain parts, as for instance, the temporal bone (Schüller's, Stenvers', and Mayer's projections).

Five illustrative cases are presented.

S. R. BEATTY, M.D.

## THE SPINE

Roentgenologic Aspects of Spina Bifida Occulta. R. J. Dittrich. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 937-944, June, 1938.

The author's conclusions are based on a study of 33 cases of spina bifida occulta (lumbosacral region). The importance of these malformations in the spine lies in their association with abnormal tissue deposits within the sacral canal, so arranged that they may interfere with the normal function of the spinal nerves. These findings have been proven by operation. The abnormal tissue consists of fat tissue with varying amounts of fibrous tissue. Some of the clinical conditions which have been found to be combined with these abnormalities are muscular rheumatism, low back pain, spastic paralysis, infantile paralysis, and hematogenous osteomyelitis.

IRVING I. COWAN, M.D.

Diseases of the Apophyseal (Intervertebral) Articulations. Albert Oppenheimer. *Jour. Bone and Joint Surg.*, 20, 285-313, April, 1938.

This is an extensive study and discussion of diseases of the intervertebral apophyseal joints. The correct method of roentgenographing the joints is first discussed, then the types of disease affecting them are defined.

*Atrophic Spondylarthritis.*—The acute form occurs suddenly and shows a homogeneous hazy shadow extending slightly beyond the margins of the articular processes. It is usually limited to one joint. The disks and the vertebral bodies are normal. The chronic form is characterized by destruction of the cartilage, the joint space being narrowed.

*Ankylopoietic Spondylarthritis* is a typical atrophic arthritis involving all the apophyseal joints with demineralization of the vertebral column. It is characterized by narrowing of the joint space and demineralization of the articular process, which later become irregular. Subsequently the joint space becomes filled with new bone, resulting in ankylosis. Secondary changes may occur, consisting in ossification of the ligaments, corresponding to the clinical entity, *spondylose rhizomèlique*.

*Hypertrophic Spondylarthritis.*—The primary lesion is in the cartilage, resulting in narrowing of the joint space, masked by articular effusion.

Primary hypertrophic spondylarthritis shows the processes increased in density, the facets ragged, the

joint spaces irregularly narrowed, and exostosis on contiguous facets. Hypertrophic spondylarthritis may result from faulty posture.

Secondary infection, traumatic lesions, tumors and anomalies of the articular processes are discussed briefly.

J. B. McANENY, M.D.

Pyogenic Osteomyelitis of the Spine, Mediastinal Abscess, and Compression of the Spinal Cord. Norman Q. Brill and David E. Silberman. *Jour. Am. Med. Assn.*, 110, 2001, 2002, June 11, 1938.

Only one similar case of this type is recorded in the literature.

The illness probably began with transient bacteremia, secondary to a furuncle on the face. Metastatic infectious involvement of the joints and the dorsal spine followed. There was extension from the spine into the mediastinum anteriorly, with abscess formation, resulting in diffuse pain in the chest, and later posterior extension into the epidural space, with consequent severe root pain. Slowly progressive compression of the cord then ensued, due possibly either to pressure of frank pus or to the formation of chronic epidural granulation tissue or both. It may have been due to changes in the cord secondary to involvement of the vessels. Operative intervention through the mediastinum permitted drainage and relieved the compression, as was revealed by the neurologic status six days after operation.

CHARLES G. SUTHERLAND, M.D.

Generalized Costo-vertebral Dystrophy. J.-P. Brinon-Cherbuliez. *Bull. et mem. Soc. de Radiol. Méd. de France*, October, 1937, 25, 635, 636.

The author presents a case of a four-year-old infant with kyphosis and thoracic deformity due to multiple deformities of the ribs and spine, with irregular vertebræ, fused in several places, and with spina bifida occulta. He believes this to be an example of the syndrome of Klippel-Feil of atypical localization.

S. R. BEATTY, M.D.

Spondylolisthesis and its Evaluation in Determining Trauma. H. Zschau. *München. med. Wehnschr.*, 85, 599-603, April 22, 1938.

After a review of the present status of the question of spondylolisthesis, a critical comparison of the theories of the origin of spondylolysis was undertaken. From this comparison one reaches the viewpoint that the theory of congenital defect is well taken. It is further shown from two examples in which the question of judgment arose in relation to the connection with an accident. The roentgenogram can do good service here, if it is made promptly; that is, immediately after the accident. In each such case judgment requires a comprehensive consideration of the entire subject. Some good illustrations are appended.

L. G. JACOBS, M.D.



## THE STOMACH

The Study of Inflammatory Gastric Granuloma. A. Rosselet, O. Mengis, and B. Ghelwe. Schweiz. med. Wchnschr., 68, 540, 541, May 7, 1938.

Report of a case of non-specific inflammatory granuloma of the stomach, in which roentgen signs of the mass were discovered. The correct diagnosis was made only at autopsy, a laparotomy also failing to show the true nature of the process. Although more than one hundred cases of this condition are in the literature, none has ever been clinically diagnosed. The authors conclude that differential diagnosis by use of roentgen examination is likewise impossible.

L. G. JACOBS, M.D.

Information Furnished by Radiologic Study of the Stomach in Dorsal Decubitus. P. Dufour. Bull. et mém. Soc. de Radiol. Méd. de France, 26, 116-118, February, 1938.

The author stresses the importance, in examination of the stomach with the opaque meal, of utilizing a number of positions from upright to Trendelenburg, varying the incidence of the rays in each position. The patient is examined in multiple positions with a small amount of barium and the procedure repeated with the full meal. Radiographs are taken in all positions to register details not observable by radioscopy. The advantages of such a complete examination are discussed.

S. R. BEATTY, M.D.

## SUPERVOLTAGE

Biophysical Foundations of Supervoltage Roentgen Therapy. Otto Glasser. Cleveland Clinic Quarterly, 5, 196-202, July, 1938.

The different methods of supervoltage (*i.e.*, above 200 kv.) production are discussed. The location of some of these installations is mentioned.

The biophysical advantages of supervoltage are given as: (1) Greater output of radiation, permitting heavier filter and greater focal-skin distance with greater depth dose; (2) greater penetration resulting in higher half value layers; (3) the possibility that the short and penetrating rays have selective action; (4) production of new types of rays, *e.g.*, neutrons, high-speed cathode rays, and artificial radio-active substances.

J. B. McANENY, M.D.

## SYPHILIS

Two Cases of Syphilitic Osteitis Resembling Osteogenic Sarcoma. Nils Westermark and Sven Hellerström. Acta Radiol., 18, 422-427, May, 1937.

The summary is as follows: "The authors report two cases of syphilitic osteitis which closely resembled osteogenic sarcoma both clinically and roentgenologically. The latter diagnosis should not be made on the basis of the roentgen film alone. A syphilitic etiology

should be excluded by careful clinical study, by the Wassermann and Müller-Ballung reactions, and by a trial of anti-syphilitic treatment in all such cases in which osteogenic sarcoma is suspected, before taking the responsibility for the mutilating treatment which this latter disease requires."

AUTHORS.

A Diagnostic Difficulty: Syphilitic Meningo-myelitis or Spinal Arachnoiditis (?). H. Tillier, F.-G. Marill, R. Raynaud, and J.-R. D'Eshougues. Bull. et mém. Soc. de Radiol. Méd. de France, 25, 750-753, November, 1937.

A case presenting radiologic evidence of arachnoid adhesions, which had clinical evidences of a myelitis, offered considerable difficulty in diagnosis, as the blood and spinal fluid gave negative reactions for syphilis. The clinical improvement after anti-syphilitic therapy made possible the diagnosis of syphilitic meningo-myelitis with arachnoiditis.

S. R. BEATTY, M.D.

## THE THYMUS

The Incidence of Enlarged Thymus Following the Prenatal Use of Iodized Salt. S. W. Donaldson and J. A. Towsley. Am. Jour. Roentgenol. and Rad. Ther., 39, 908-915, June, 1938.

The literature is reviewed to show the relationship of thyroid disease and thymic hyperplasia. A series of roentgenograms of the thymus was taken before the introduction of iodized salt and this group is compared with a recent series after the introduction of iodized salt. The comparison indicates a decrease of approximately 55 per cent in the incidence of thymic enlargement.

IRVING I. COWAN, M.D.

## TUBERCULOSIS, PULMONARY

Stenosis of the Pulmonary Artery and Pulmonary Tuberculosis. F.-G. Marill and R. Raynaud. Bull. et mém. Soc. de Radiol. Méd. de France, 25, 745-747, November, 1937.

In a case of stenosis of the pulmonary artery the onset and course of fatal pulmonary tuberculosis was rapid. The focus was probably a large calcified area in the hilum, and the rapidity of progression probably associated it with pulmonary congestion.

S. R. BEATTY, M.D.

Hematogenous Pulmonary Tuberculosis. William A. Zavod. Jour. Am. Med. Assn., 109, 1693-1698, Nov. 20, 1937.

Pulmonary hematogenous tuberculosis is a pulmonary dissemination of the bacilli of tuberculosis by way of the lesser blood circle, mainly, in contradistinction to generalized miliary tuberculosis, which is a widespread

dissemination of the bacillus of tuberculosis by way of both the greater and the lesser blood circles.

A roentgenogram of the lungs invaded by such a dissemination will show miliary seeding throughout both lungs and the roentgenologist will justly report "miliary tuberculosis." The clinical picture, however, while that of miliary tuberculosis in some cases will show very little to justify such a diagnosis in others. The fatal type of miliary tuberculosis and the comparatively benign dissemination "hematogenous tuberculosis" appear nearly alike roentgenographically; one must turn to the clinical signs and symptoms and possibly to a period of observation as the basis for a differential diagnosis.

Pulmonary hematogenous tuberculosis occurs most frequently during childhood and in young adults who were heavily exposed to tuberculosis during childhood. Repeated attacks are not infrequent. Continued close contact with open cases of tuberculosis favors repeated disseminations, especially in childhood. Undernourishment and general poor health are additional predisposing factors.

Early hematogenous disseminations show an evenly distributed seeding of nodules varying in size from one to several millimeters, with the greatest density in the upper halves in the roentgenogram. The hilar nodes may either be still large or show heavy calcium deposition. Periodic roentgenograms of retrogressive lesions show a gradual caudo-apical fading out of the infiltrations, and the nodules in the upper portion of the lung persist the longest. In some cases all roentgenographic evidence of disease may disappear within a few months to a year. In other cases the fine hematogenic nodules may become fibrosed or even calcified and persist throughout life. Dense invasion of the upper halves of the lungs may lead to heavy fibrosis, appearing as dense homogeneous shadows symmetrically distributed; the lower halves show increased transillumination due to emphysema.

CHARLES G. SUTHERLAND, M.D.

Pulmonary Tuberculosis and Syphilitic Aortitis Associated. Ch. Viallet, R. Marchioni, and A. Lévi-Valensi. *Bull. et mém. Soc. de Radiol. Méd. de France*, 25, 742-745, November, 1937.

Fibro-ulcerative tuberculosis is more frequent in syphilitics than in the general run of cases. A case of syphilitic aortitis and pulmonary tuberculosis characterized by cavitation, marked fibrosis, and calcification is presented.

S. R. BEATTY, M.D.

Co-existing Pulmonary Tuberculosis and Primary Carcinoma of Lung. Charles P. Larson. *Northwest Med.*, 37, 183, 184, June, 1938.

Reviewing the current literature the essayist finds "a great divergence of opinion as to the frequency of co-existing active pulmonary tuberculosis and primary carcinoma of the lung." Series of autopsies compiled by different men, some showing high incidence, others

low incidence, are cited. The statistics from the larger tuberculosis clinics, however, show the co-existence of primary carcinoma of the lung and pulmonary tuberculosis to be extremely rare.

F. G. Cooper reviewed the literature in 1934 and was able to collect only 39 cases of this type. E. J. Simons is quoted as saying, "Statistics prove that tuberculosis is not an important cause of carcinoma but it may be considered responsible for the origin of carcinomas in a small proportion of cases, more on the grounds of chronic irritation and metaplasia than on any other."

The writer believes that the frequency of the co-existence of these two conditions has not been established and that it is rather difficult to understand how a cancer could originate in the wall of a tuberculous cavity lined by connective tissue. However, he further states that a bronchus may connect with this cavity, from which the cancer may possibly originate.

Two cases in which tuberculosis and primary malignancy of the lung co-exist are reported, and in his comments Larson states, "Both of these cases would tend to substantiate Ewing's viewpoint that tuberculosis is one of the etiologic factors in the production of primary carcinoma of the lung."

A. MAYORAL, M.D.

Tomography in the Radiology of the Chest. F. G. Stewart. *Irish Jour. Med. Sci.*, sixth ser., No. 150, June, 1938, pp. 277-282.

This is a study of 50 cases of pulmonary tuberculosis by the usual x-ray method and by tomography. The latter study enhances the findings in chest conditions. The usefulness of chest tomography is classified as follows:

I. Demonstration of unsuspected findings radically altering the conception of the disease.

II. Demonstration of unsuspected findings modifying the conception of the disease.

III. Demonstration of unsuspected findings not appreciably modifying the conception of the disease.

IV. More precise demonstration of suspected findings.

V. Confirmation of plain films. Nothing new added.

Cases are presented demonstrating each class. The admonition not to exclude other methods of examination is given. The greatest advantage of chest tomography seems to be in those cases showing pathological lesions in the plain films.

J. B. McANENY, M.D.

## TUBERCULOSIS, SURGICAL

Operative and Conservative Treatment of Tuberculosis of the Spine: A Comparative Study. Harry Finkelstein, Benjamin B. Greenberg, Samuel A. Jahss, and Leo Mayer. *Jour. Am. Med. Assn.*, 110, 480-483, Feb. 12, 1938.

This was a comparative study extending over a ten-year period and limited strictly to children up to the

age of 20 years. Tuberculosis in the adult differs radically from the disease in children. Patients admitted to the country home of the Hospital for Joint Diseases were divided as impartially as possible into two groups, each of which was given exactly the same dietetic and general hygienic treatment, but in one group fusion operations were done and in the other conservative methods alone were followed. In all, 43 cases were studied: 26 patients were treated by fusion procedures and 17 by purely conservative measures. The authors' criteria for cure were: (1) Pain, fever, muscle spasm, and tilt of the body must completely disappear for at least three months; (2) abscesses must disappear both clinically and roentgenographically and sinuses must close; (3) in the roentgenogram there must be evidence of increased calcification in the area of destruction, cessation of all advance of the process, and a so-called bloc formation.

The fusion operation did not shorten the duration of the disease but, on the contrary, prolonged its course. The pathologic process in the vertebrae was apparently uninfluenced by the operation. The progression seemed to occur despite fusion.

CHARLES G. SUTHERLAND, M.D.

Spontaneous Fracture in Isolated Tuberculosis of the Shaft of the Ulna. C. H. Grasser. *Schweiz. med. Wehnschr.*, 68, 533-535, May 7, 1938.

A case of a proven isolated tuberculosis of the upper end of the ulnar shaft with pathologic fracture is reported because of its rarity. The fracture united with some improvement in the status of the tuberculosis. No other tuberculous foci were found.

L. G. JACOBS, M.D.

Tuberculosis of a Supernumerary Vertebra. Lauro Laureati. *Minerva Med.*, 29, 396, April 7, 1938.

The author claims that his is the first case to be reported. The lesion occurred in a supernumerary vertebra in a baby of 14 months.

E. T. LEDDY, M.D.

## TUMORS, DIAGNOSIS

\*Ovarian Fibroma with Ascites and Hydrothorax (Meigs's Syndrome): Report of Case. J. E. Rhoads and Alexander W. Terrell. *Jour. Am. Med. Assn.*, 109, 1684-1687, Nov. 20, 1937.

The syndrome of fluid in the chest associated with ovarian fibroma was recently reported. The knowledge that this association of pleural effusion with a benign pelvic tumor exists is extremely important from the standpoint both of prognosis and of treatment, since most pelvic tumors causing pleural effusion are malignant and the effusion is the result of pleural or pulmonary metastasis. In the presence of massive pleural effusion it may at times be impossible, even after partial aspiration, to exclude the presence of pulmonary metastasis by x-ray examination.

The occurrence of hydrothorax with a pelvic tumor justifies abdominal exploration and promises substantial hope of recovery in a considerable group in which the prognosis was previously regarded as hopeless.

The mechanism of the relationship is not known. Several explanations of the ascites associated with ovarian fibromas seem plausible, but no explanation of the hydrothorax has as yet been afforded.

CHARLES G. SUTHERLAND, M.D.

Stenosis of the Duodenum by a Tumor of the Third Portion. Albert Poirier. *Bull. et mém. Soc. de Radiol. Méd. de France*, 25, 771-773, November, 1937.

A case of lymphocytoma (sarcoma?) of the third portion of the duodenum, causing almost complete obstruction, is presented by the author.

S. R. BEATTY, M.D.

A New Case of Osteosarcoma of the Ischium Treated as Sciatica and Revealed by Radiography. T. Nogier. *Bull. et mém. Soc. de Radiol. Méd. de France*, 26, 112, 113, February, 1938.

A patient shown to have extensive destruction of the ischium and part of the ilium and pubis had been treated for over 18 months for sciatica by a number of doctors who failed to take roentgenograms.

S. R. BEATTY, M.D.

A Case of Myeloma. L. Magnabosco and M. Francescon. *Minerva Med.*, 29, 387-390, April 7, 1938.

The authors report a case of myeloma which involved a rib and a vertebra in a man 34 years of age. The diagnosis was confirmed by x-ray examination and by sternal puncture. The lesion was of the monocytic type.

E. T. LEDDY, M.D.

Considerations on the Multiple Manifestations, Osseous and Glandular, of a Malignant Lymphoid Tumor. L. Berard, P. Ponthus, and A. Notter. *Bull. et mém. Soc. de Radiol. Méd. de France*, 26, 104-106, February, 1938.

The authors discuss the difficulty of arriving at a final diagnosis, despite histologic and radiologic studies, of a case of neoplasm of the left ilium with metastasis to the regional nodes, mediastinum, and pleura. The tumor was probably a lymphoblastoma.

S. R. BEATTY, M.D.

The Relation of the Presenting Symptoms to the Selection of the Method of Treatment in Uterine Myoma. Henry Schmitz. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 849-854, June, 1938.

The methods of treatment of uterine myomas that produce symptoms are medical, surgical, and radiological. From a study of 263 consecutive cases of uterine

myomas, the author has found that there are indications for each type of treatment based on (1) the symptoms (menorrhagia, metrorrhagia, pain, or a combination of these symptoms), (2) the relation of these symptoms to the physical findings, and (3) the age groups.

The indications for the various forms of treatment are described and the author shows by a review of his cases that the results of the selection of the method of treatment had been a very low mortality and morbidity, and a high percentage of cure.

IRVING I. COWAN, M.D.

Primary Malignant Tumors of the Urogenital Tract in Infants and Children. Meredith F. Campbell. *Jour. Am. Med. Assn.*, 109, 1606-1611, Nov. 13, 1937.

Hypernephroma accounts for from 2 to 11 per cent of malignant renal tumors in children and appears to be more common in girls. Hypernephroid tumors by biologic assay have shown a content of cortical hormone (adrenal cortex extract) comparable in amount to that found in the normal adrenal. This tends to support the Grawitz theory of adrenal cell rests as the origin of these tumors. Hypernephroma metastasizes by the lymphatics, blood stream, and direct extension; the lungs and long bones are most apt to be involved. Hematuria is the dominant early symptom of hypernephroma in children, quite in contrast to the initial symptom of a mass in the loin such as occurs in Wilms' tumor. Sometimes the passage of large blood clots produces renal colic, but otherwise pain in the loin is due chiefly to distention of the renal capsule by the growth. When the diagnosis is made early and prompt nephrectomy follows, the prognosis is slightly better than for Wilms' tumor. The results of irradiation are not as phenomenal in patients with hypernephroma as in those with Wilms' tumor, yet such therapy may advisedly be employed both pre-operatively and post-operatively. Chief reliance must be placed on early diagnosis and nephrectomy.

Embryonal adenomyosarcoma (congenital mixed tumor, Wilms' tumor) is the commonest neoplasm of the urinary tract and abdomen in the young, in whom it constitutes about a fifth of all tumors. Seventy-five per cent of Wilms' tumors appear before the fifth year, and two-thirds appear before the third year, which is about the average age at which the tumors are first recognized. After the seventh year hypernephroma is more apt to occur than embryonal adenomyosarcoma.

In Wilms' tumor a fifth of the patients show metastasis. The spread is characteristically through the blood stream, yet by lymphatic or direct extension the liver, spleen, spine, intestine, diaphragm, and lungs may be invaded. Less frequently the skull, brain, scapula, ilium, abdominal and lumbar muscles, and even the corpora cavernosa have been the site of metastasis.

Intravenous (excretory) urographic studies may suffice to make the diagnosis. Only a retrograde pyelogram can be relied on for a clear urographic demonstration of the pelvis of a tumor-bearing kidney in a child.

Tumors of the renal fibrous capsule are extremely

rare; when found they are predominantly sarcomatous. Tumors of the renal pelvis are so scarce in children as to merit scant clinical consideration.

Tumors of the ureter in children are almost exclusively secondary to renal tumors and, even so, are seldom seen.

Tumors of the bladder are most unusual in children and are predominantly of mesodermal origin; more than half are sarcomas, a few are myxomas, and the remainder are fibroids, polyps, rhabdomas, dermoids, myomas or papillomas.

Malignant growths of the penis and urethra are almost unknown in the young.

Approximately 150 cases of tumor of the testicle in children have been reported. Examination of the growths shows them to be of congenital or embryonal origin. The embryonal tumor is the one characteristically seen in children.

Tumors of the prostate are extremely rare and in children are almost exclusively sarcomatous.

The important malignant adrenal tumor in children is the neuroblastoma or neurocytoma; it occurs fully a third as often as malignant renal tumors. Neuroblastomas grow rapidly and not only push the kidney down but are likely to protrude posteriorly—a point differentiating them from renal tumors. The growths metastasize rapidly, principally through the lymphatics.

CHARLES G. SUTHERLAND, M.D.

A Case of So-called "Kahler-Bozzolo Syndrome." Angelo Sacchetti. *Minerva Med.*, 29, 360-363, March 31, 1938.

This syndrome, also called "multiple myeloma," is characterized by painful, brittle bones, anemia, asthenia, and the elimination of Bence-Jones protein in the urine. Roentgenologically there are numerous irregularly sized and shaped areas of absorption in the bones involved. In the author's case the possibility of metastatic carcinomatous involvement of bone seems to have been eliminated and it is, therefore, a true case of multiple myelomas. There was no autopsy.

E. T. LEDDY, M.D.

Radiologic Study of a Rounded Interthoracic Shadow. L. Berard, P. Ponthus, and A. Notter. *Bull. et mém. Soc. de Radiol. Méd. de France*, 26, 102-103, February, 1938.

The differential diagnosis of an interthoracic tumor in a man with an epithelioma of the nose and von Recklinghausen's disease is discussed, with reference to metastatic malignancy, neuroma, von Recklinghausen's tumor, and dermoid cyst.

S. R. BEATTY, M.D.

The Roentgen Aspect of Sympathetic Neuroblastoma. Howard P. Doub. *Jour. Am. Med. Assn.*, 109, 1188-1191, Oct. 9, 1937.

Sympathetic neuroblastomas (neuroblastomas or sympathoblastomas) are neurogenic in origin. The

tumors arise from undifferentiated cells of the sympathetic nervous system, though their origin is not confined to adrenal tissue. They may also arise in the sympathetic ganglions along the spine, especially in the cervical area. These tumors are seen most commonly in children under the age of 4 years but may also occur in adults and are said to be more common in males. They are in all probability congenital.

An abdominal mass may be the first most prominent observation. In some cases the metastatic lesions attract the first attention. The clinical course is usually characterized by a rapid decline, followed by death in a few months. There may be manifestations of temporary improvement following radiotherapy, but relapse soon occurs. The local tumors frequently appear to respond to radiotherapy, but this has no apparent effect on the development of distant metastasis.

The roentgenographic changes in the skull consist of widening of the sutures and increased digital markings indicative of increased intracranial pressure. In addition, there is evidence of involvement of the bones of the skull, manifested by minute foci of resorption, which produces a finely granular type of osteoporosis. The flat bones of the pelvis show a type of infiltration similar to that in the skull.

	Cases treated	Cured by first treatment	Cured after recurrence	Total cures	Not cured
Epithelioma of face	353	304 (86.1%)	17	321 (90.9%)	32 (9%)
Epithelioma of lips	43	30 (69%)	3	33 (76%)	10 (24.2%)
Epithelioma of eyelids	30	27 (90%)	2	29 (96.6%)	1
Epithelioma of back of hand	7	5 (71.3%)	0	5 (71.3%)	2
Total	433	366 (84.5%)	22	388 (89.6%)	45 (10.3%)

This type of involvement appears to be the characteristic lesion in the flat bones. In the long bones, various types of lesion are seen. Elevation of the periosteum is frequently present and may be local or may extend along the entire length of the shaft. Areas of metastatic involvement, with bone resorption, are seen in any of the long bones. These changes are more apt to be in the ends of the diaphyses, adjacent to the epiphyseal lines. In advanced cases these changes may extend the full length of the shaft of the bone. In many instances the resorption is of uneven density, suggesting a diffuse infiltration rather than a massive destruction. Osteoporosis of an extreme grade may precede actual dissolution of the bone structure.

CHARLES G. SUTHERLAND, M.D.

Tumorlike Picture in Tabetic Arthropathy. W. Schröder. München. med. Wchnschr., 85, 911-914, June 17, 1938.

The author points out that a Charcot joint of the hip is easily confused clinically with tumor. The swelling, usually painless, irregular, bony hard, and slow-growing, resembles chondroma or sarcoma. The roentgenologic distinction is not so difficult. In chondroma, the cystic rarefactions are surrounded by compacta and often by periosteal layers. Sarcomas may be either osteolytic or osteoplastic, usually localized below the metaphysis, and are not sharply demarcated. Epiphyseal and

joint cartilage is seldom crossed. In tabes, marginal proliferation, loss of joint space, dislocations, and fractures in various stages of healing with exuberant callus, irregular bone ends, periosteal deposits, and capsular calcifications and ossifications are seen. Four case reports in which diagnostic difficulties arose are cited.

L. G. JACOBS, M.D.

## TUMORS, THERAPY

Statistical Results of Treatment of Cutaneous Fibromas and Epitheliomas by Radiotherapy of Moderate Penetration. Ducellier. Bull. et mém. Soc. de Radiol. Méd. de France, 25, 778, November, 1937.

*Fibromas: Method of Bédère.*—Fibromas treated, 153; cured in 16 sittings, 142 (92.8 per cent); cured in more than 16 sittings, 3; total cures, 145 (94.7 per cent); not cured, 8 (5.3 per cent). The cases not cured were eight errors in diagnosis: co-existence of fibroma with cancer of the body, of fibroma and ovarian cyst.

### Cutaneous epithelioma

S. R. BEATTY, M.D.

A Case of Chorioepithelioma Cured by Irradiation Therapy. G. Melot. Bruxelles-méd., 17, 1407-1412, July 25, 1937.

This case of chorioepithelioma of the anterior portion of the vagina in a woman of 39 years was treated with radium and x-rays in December, 1935. In March, 1937, she was alive and in good health and the Friedman-Brouha test was negative. The dose given with the radium was equivalent to 9,000 r at 12 mm. and external irradiation through four fields was given to a depth dose of 1,800 r. The author has reviewed the literature and discusses the diagnosis and treatment of chorioepithelioma in some detail.

S. R. BEATTY, M.D.

The Effect of Short Electric Waves on Malignant Tumors. S. Baumeier. Strahlentherapie, 1938, 62, 373.

The author briefly discusses the literature regarding the effect of short electric waves on malignant neoplasms. He had an opportunity to study the combined effect of short electric waves and x-rays on metastatic nodules in the thigh of a woman who had a primary carcinoma of the cervix. One nodule was treated by the combined method, the other nodule by

x-rays only. A comparison of the two nodules 10 days after the last treatment showed that the nodule which had received x-rays alone was smaller. The author deduces, therefore, that short electric waves have no influence on malignant tumors, that simultaneous treatment of malignant tumors by short electric waves and roentgen rays may cause an increase in the size of the growth, that a sensitization is apparently not possible, and that, therefore, malignant tumors should not be subjected to treatment by short electric waves.

ERNST A. POHLE, M.D., Ph.D.

Treatment of Cancerous Adenopathies Secondary to Malignant Tumors of the Upper Air and Alimentary Passages. L. Ducuing. Bull. et mém. Soc. de Radiol. Méd. de France, 25, 764-768, November, 1937.

The author discusses briefly the anatomy, pathology, and clinical considerations in treatment of metastatic carcinoma from foci in the upper air and alimentary passages. The treatment, considered more in detail, is either surgical, radiologic, or combined. While surgery occupies a very definite place, it is becoming more and more replaced by radiologic methods, telecurie-therapy or roentgen irradiation by the method of Cou-tard.

S. R. BEATTY, M.D.

Urography in Infants. Einar Perman and A. Lichtenstein. Acta Radiol., 18, 413-421, May, 1937.

The summary is as follows: "The authors describe a method of obtaining urograms on infants by means of subcutaneous and intramuscular injection of 7.5 per cent parabrodil solution. A prerequisite for a very good result is that the child sleep during the procedure for only then is a compression of the ureters effective. Luminal or chloral are, therefore, given before the investigation. Good urograms have been obtained on children as young as three months of age."

AUTHORS.

## THE UTERUS

X-ray Treatment of Carcinoma of the Cervix. Carlo Guarini. Archivio di Radiologia, 13, No. 4, 348, 349, 1937.

This is a statistical analysis of 569 cases of carcinoma of the cervix treated between 1922 and 1936. In general, the best results were obtained by a modified Wintz technic in that treatment was not given in one session. Of the 569 cases, 31.8 per cent were living at the end of 1936. The highest mortality was in Groups III and IV. The final result in 19 per cent of the cases is unknown. Within from one to five years after treatment, 34.1 per cent died. He obtained the best results in cases in Group I, only 3 per cent of the total number, of which 36 per cent are living up to ten years after treatment.

E. T. LEDDY, M.D.

Radium *versus* Roentgen Radiation in the Treatment of Benign Uterine Bleeding. John W. Cathcart. Am. Jour. Roentgenol. and Rad. Ther., 37, 513, April, 1937.

The writer has come to the conclusion in recent years that patients treated by roentgen rays for benign uterine bleeding do better than those who receive radium alone or radium plus x-rays. This impression is based upon the general feeling of well-being of the patient while under observation and treatment, the extent of psychic trauma incident to the procedure, the number and severity of post-treatment complaints, and the smoothness of the patient's life in medical matters in subsequent years.

The opinion of other radiologists representative of American radiation therapists was sought and it was found that the majority favored roentgen radiation except under circumstances and in patients in whom it was obviously desirable to use radium. If the more slowly induced menopause is less disadvantageous to the patient from the general standpoint, then the roentgen ray should be given preference.

J. E. HABBE, M.D.

# ANNUAL MEETING

## THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC.

NOVEMBER 28 to DECEMBER 2, 1938

## HOTEL WILLIAM PENN PITTSBURGH, PA.

### EXECUTIVE SESSIONS

MONDAY, November 28th - - - - - COUNSELOR'S DINNER  
7:00 P.M.

Reports of Officers, Committees and Counselors  
Appointment of the Nominating Committee

TUESDAY, November 29th - - - - - BUSINESS SESSION  
2:00 P.M.

Report of the Nominating Committee  
CARMAN LECTURE

8:30 P.M.

THURSDAY, December 1st - - - - - BUSINESS SESSION  
2:00 P.M.

Election of Officers

### THE BANQUET—

Presidential Address  
Installation of the new Officers

7:00 P.M.



All resolutions to be acted upon at the annual meeting in Pittsburgh, Penna., should be presented to the RESOLUTIONS COMMITTEE before the Executive Sessions.

Lowell S. Goin, M.D., Chairman  
Edward P. McNamee, M.D.  
Orion O. Feaster, M.D.

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J. E. HABBE, M.D.



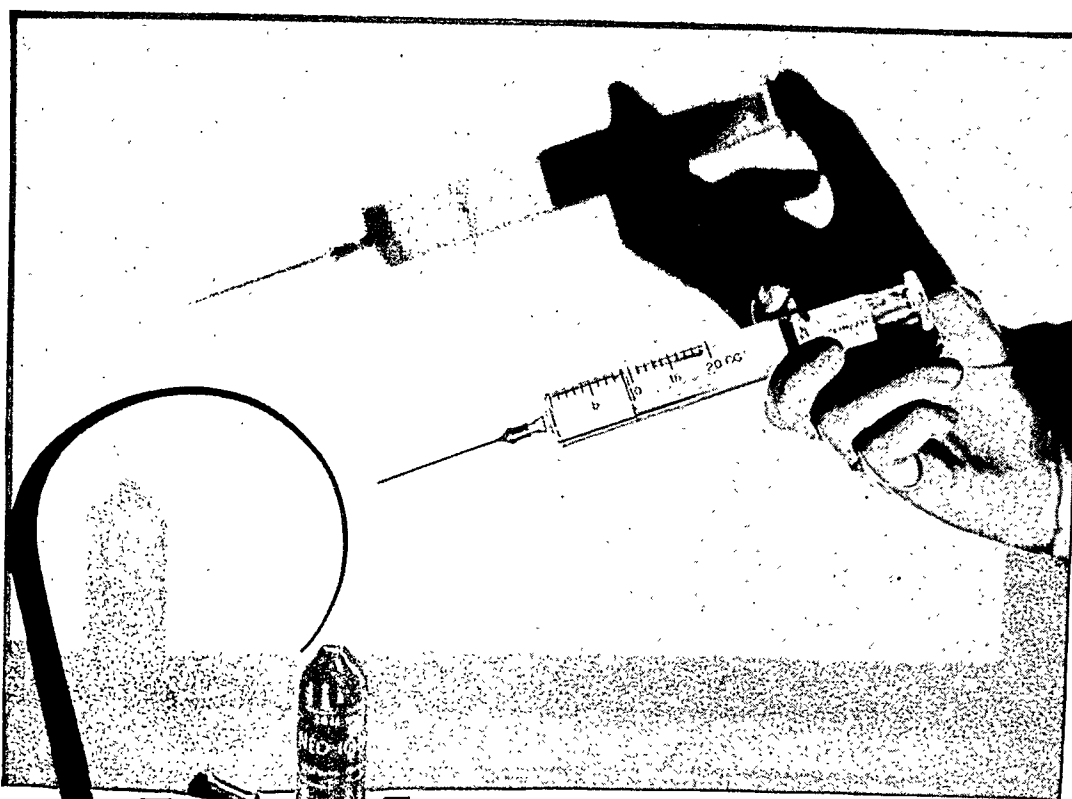


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Reverse Side of this Page . . . .***

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PROJECTION	Postero-anterior	SCREENS	Eastman <i>High-Definition</i>
THICKNESS	17 cm.	KV.P.	88
ANODE-FILM DISTANCE	25"	MA.S.	40
P-B DIAPHRAGM	8-1 grid-ratio	DEVELOPMENT	Kodalk X-ray
TUBE	1.5 mm. focal spot		Developer (3½ min., 65° F.)
FILTER	1 mm. aluminum	FIXATION	Eastman X-ray Fixer

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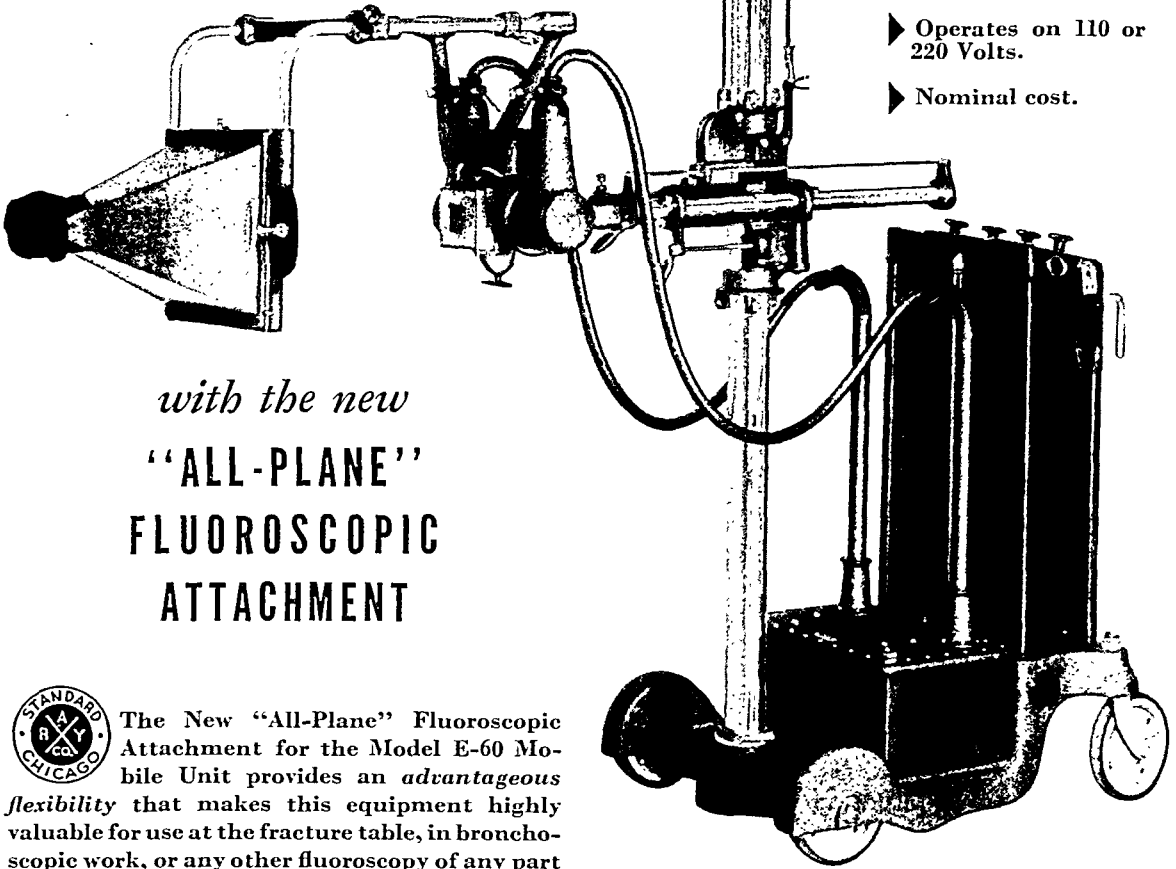
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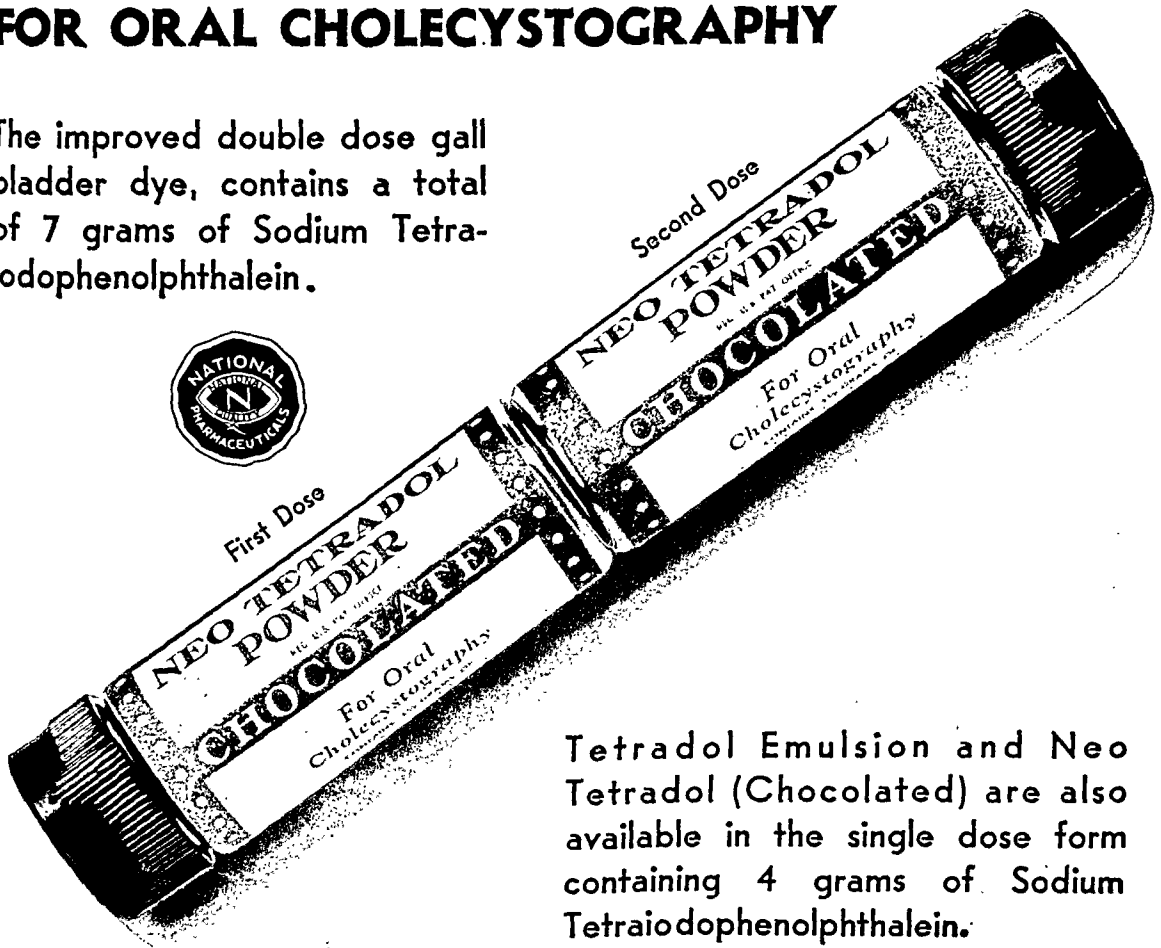
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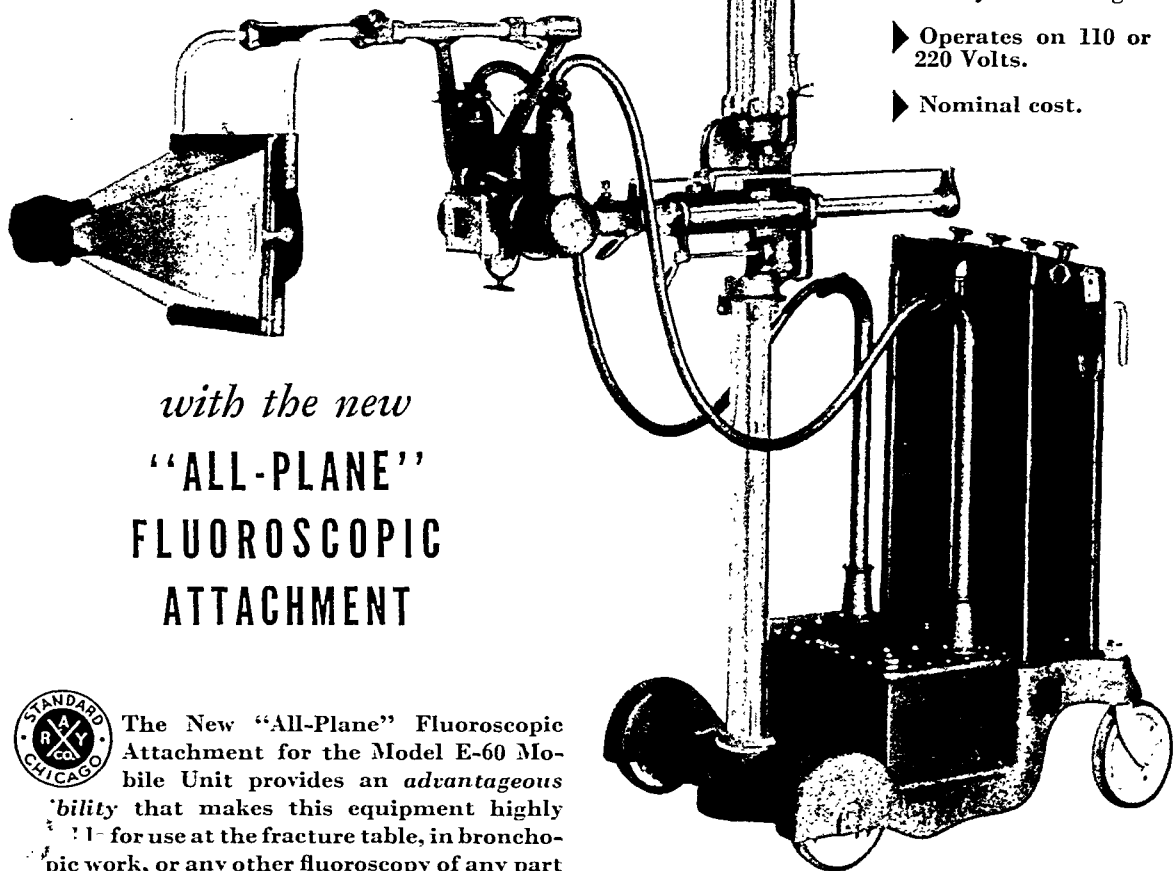


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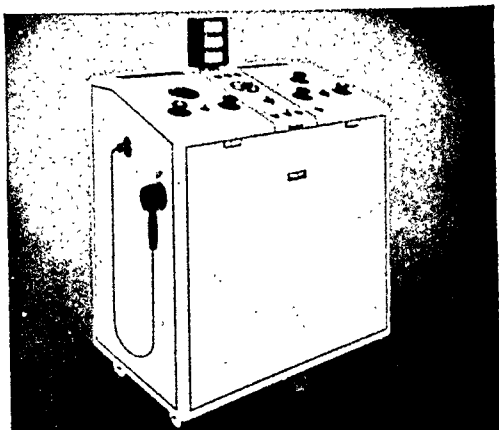
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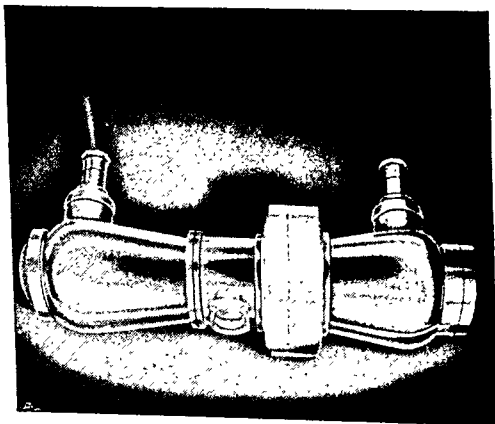
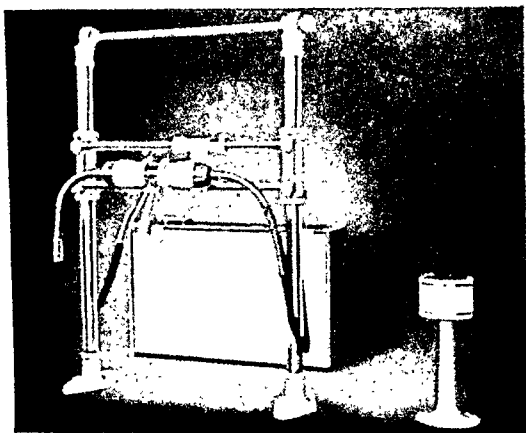
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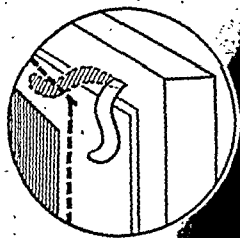
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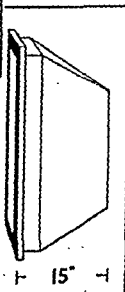
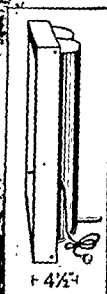
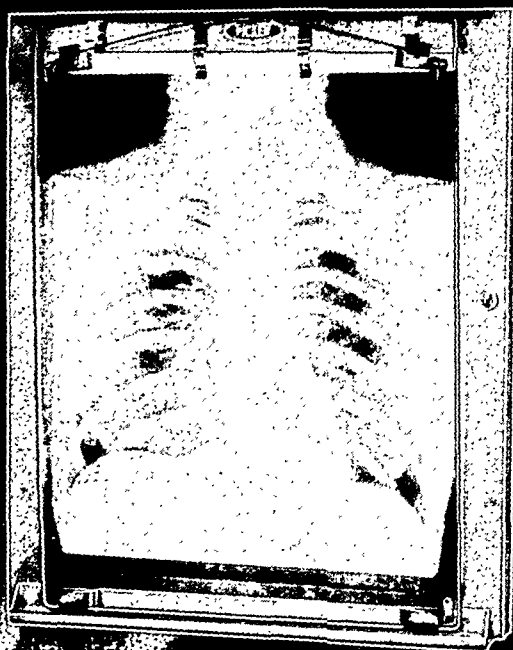
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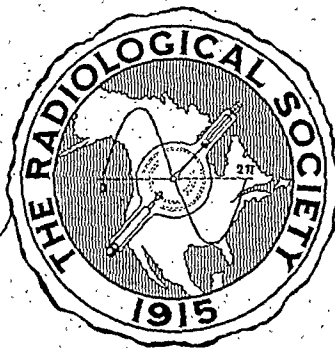
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NOV. 28-DEC. 2, 1938

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED  
TO CLINICAL RADIOLOGY AND  
ALLIED SCIENCES



NOVEMBER · 1938

VOLUME 31

NUMBER 5

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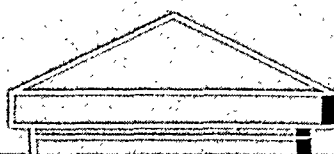
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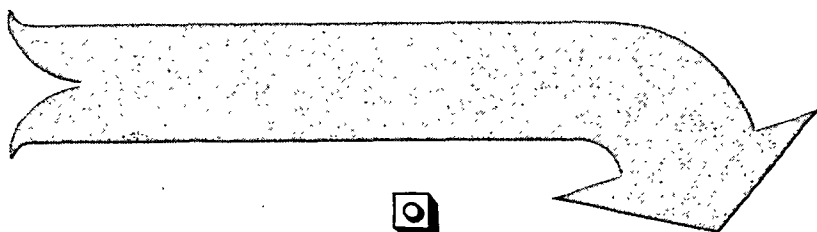
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## GENERAL INFORMATION

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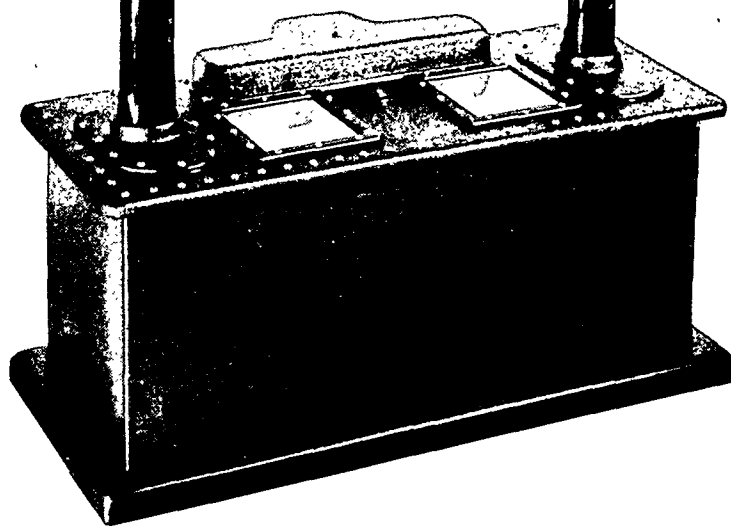
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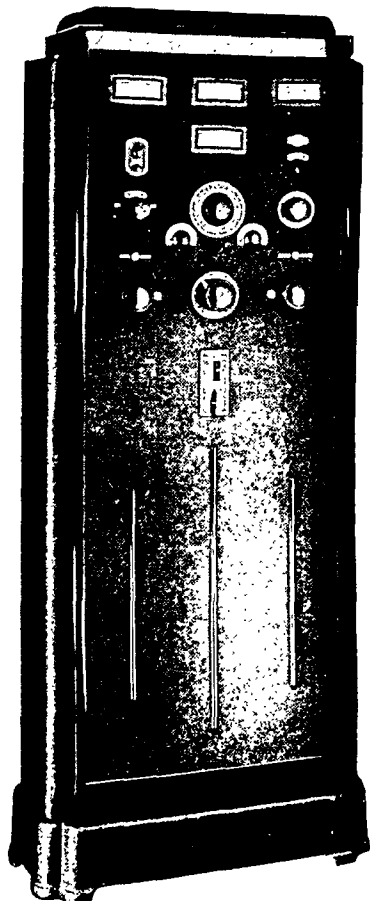
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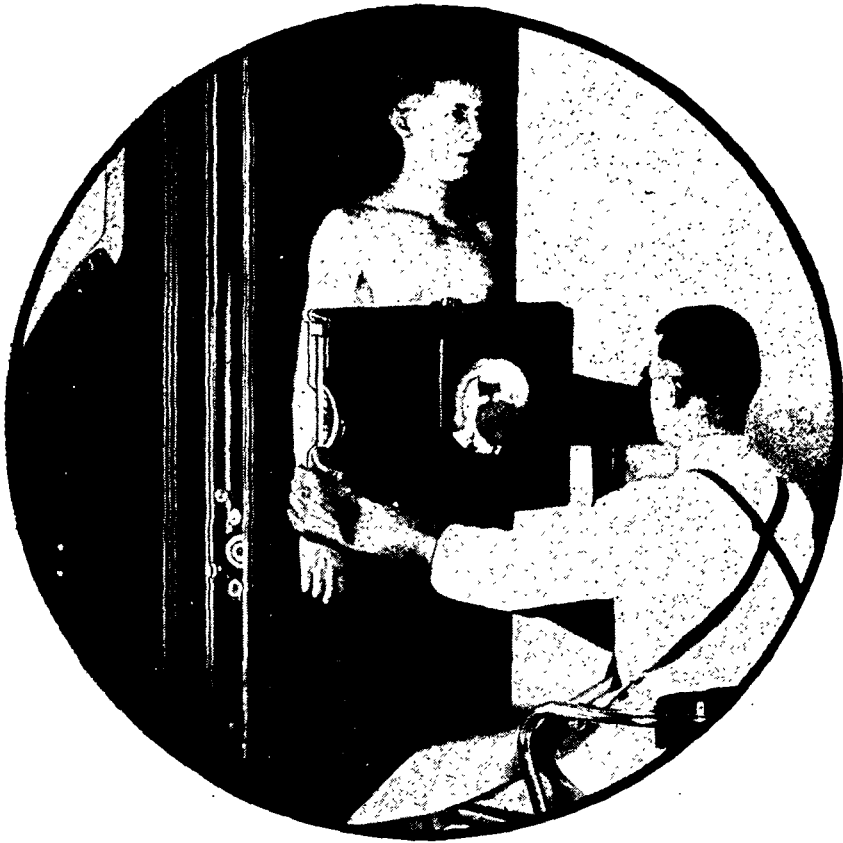


# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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No. 5

## THE ROENTGEN DIAGNOSIS OF DESTRUCTIVE LESIONS OF THE KNEE JOINT AND ITS LIMITATIONS

AN EXPERIMENTAL STUDY<sup>1</sup>

By ERNST LACHMANN, M.D., *Oklahoma City, Oklahoma*

X-ray Laboratory, Department of Anatomy, University of Oklahoma School of Medicine

THE knee joint is one of the favored sites of destructive lesions, both inflammatory and tumorous. The roentgen study of this region, therefore, appears of profound importance. Based on a previously published analysis of its roentgen anatomy the subject of this paper is an experimental approach to its roentgen pathology. Here Chasin has shown the way. Others have attacked the same problem by a comparison of x-ray findings with those presented at operation or autopsy. Unfortunately it is in most cases only the advanced lesion which allows such a comparative study. Thus textbook descriptions of x-ray symptomatology often fit only the later stages of a disease. Systematic discussions of the roentgenology of early bone lesions are scant. In order to avoid empty speculations they would have to be based on pathologic studies as offered by animal experiments or on chance findings in human autopsies. Moreover, they require a thorough understanding of the physical and optical qualities of the roentgen rays in their application as a diagnostic method, as discussed in a previous paper (Lachmann and Whelan). But since the physical factors of density and

dimensions play such an important rôle for x-ray appearance of bones we cannot make any direct use of experiments on animals, especially small laboratory animals in which the conditions are so different from man in regard to structure and diameter of bone.

Thus experiments on human skeletons seem to be a possible way to come to a better understanding of the x-ray diagnosis of bone lesions. This method was used for the first time in a systematic way by Chasin in 1928. By producing artificial defects in the spinal column he demonstrated the limitations of radiology as a diagnostic procedure. Later he followed that with studies on the knee and hip joint. In using this method we have to realize that we can imitate only the destructive phase of bone pathology, while accompanying reparative and productive processes are not adaptable to our procedure.<sup>2</sup> Figures 1-A and 1-B show the comparison of an actual destructive process in the patella and an artificial excavation in a macerated bone: the similarity is striking.

The method of Chasin requires exten-

<sup>1</sup> Aided by a grant from the Research Appropriation of the University of Oklahoma Medical School.

<sup>2</sup> In a previously published group of experiments (Lachmann and Whelan) we used the experimental approach of chemical decalcification to determine the limitations of radiology in the diagnosis of osteoporosis.

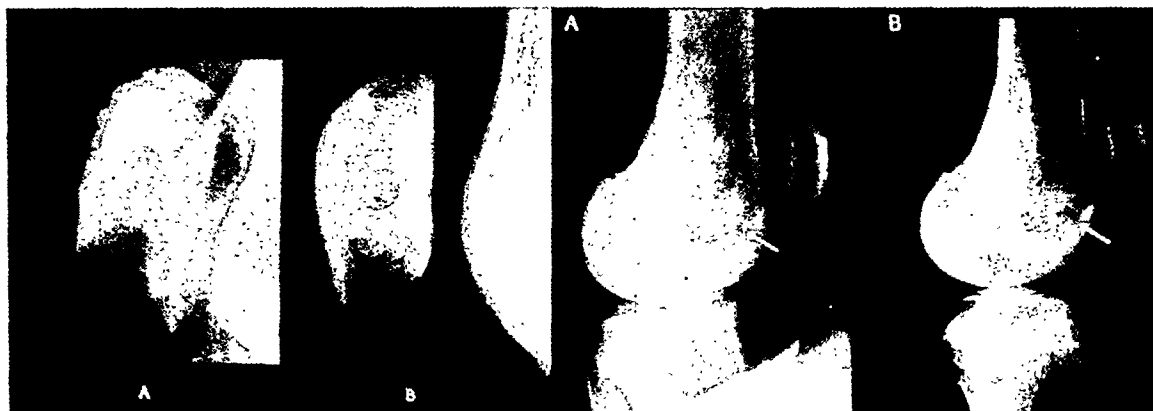


Fig. 1-A.

Fig. 1-B.

Fig. 2-A.

Fig. 2-B.

Fig. 1-A. Roentgenogram of tuberculosis of the patella. (Taken from C. Blumensaat, "Die entzündlichen Erkrankungen der Kniescheibe." *Ergebn. d. Chir. u. Orthop.* Vol. 29, 1936, Julius Springer, Berlin.)

Fig. 1-B. Artificial conoid defect in spongy matter of patella after bone has been split in sagittal plane. Diameter of base of defect 0.5 cm., depth 0.5 cm.

Fig. 2-A. Cortical defect on lateral surface of lateral condyle of femur on a knee surrounded by its muscles and ligaments (see arrow).

Fig. 2-B. Same knee after removal of soft structures and maceration of bone. Visibility of defect not markedly improved. Diameter of base of defect 0.5 cm., depth 0.5 cm.

sion and supplement in many respects. A systematic approach to the bones under discussion seems necessary. Defects have to be arranged in such a fashion that they cover all possibilities as to location and involve cortex and spongy layer separately and combined. The size of the excavations should be determined not only by measurements but also actually demonstrated by filling with contrast medium. The change in translucency of these defects, depending on their filling with paraffin or bone detritus, should be studied; also one should determine to what extent the soft structures surrounding bone and the mineral contents of the osseous tissue in the neighborhood of the defects influence their visibility. The experiments should be closely correlated with clinical destructive lesions, and attention should be directed to the importance of different projections for the demonstrability of these foci. Finally, an explanation for the different degrees of visibility of defects of the same size based on an x-ray anatomical analysis should be attempted.

#### EXPERIMENTAL

More than 190 defects were produced on various skeletons of the knee joint.

For these experiments we used either macerated bones or the complete knee region of embalmed cadavers with all soft structures preserved, or knee joints with only the ligaments attached. The defects were produced by trephining the bone with bits of different size or by various instruments, as dental burs and files, and involved the cortical, spongy, or both layers of the distal end of the femur, proximal end of the tibia, and patella. In the experiments on the patella the bone was always radiographed together with the underlying femur and tibia. When defects were produced on bones surrounded by soft structures, the bone was exposed by a few incisions and, if necessary, split. After the excavations on intended sites had been produced the soft structures were replaced and the skin sutured over them. All defects were filled with paraffin, which has approximately the same absorption coefficient as soft structures or wound exudate. The defects, if cortical, were disk-shaped; if deeper and involving the spongy layer, they were conoid-shaped. If the excavations were located in the spongy structures only, the bone was split before the experiment. The defects were always carefully measured and their

size finally demonstrated by roentgenographing them with an opaque mixture of barium and paraffin. The roentgenographs before and after trephining were taken under identical conditions of position and exposure.

The experiment on a given bone was usually started with a size at which we did not expect visibility on the x-ray film; then the excavation was gradually enlarged in all three dimensions and roentgenographed in intervals. Careful comparison with the film of the untreated control and with the films showing the defects filled with opaque material enabled us to recognize the faintest signs of destruction on the roentgenograph, stages which we would not expect to be visible in an actual clinical case. Cortical defects were gradually deepened toward and into the spongy part.

In justification of our experiments on macerated bones a defect was produced on a knee surrounded by its muscles and ligaments and roentgenographed, the soft structures were then removed, the bones macerated and roentgenographed. The films are shown in Figures 2-A and 2-B. The translucency of the defect on the lateral surface of the lateral condyle of the femur is not noticeably increased by removing the surrounding soft parts (see arrow). Anteroposterior views did not show the excavation in either case. Our further experiments likewise did not demonstrate pronounced differences between macerated bones and bones enclosed by soft structures in regard to the visibility of defects.

The roentgenographs of Figure 3 illustrate our technic. *A* is the control film showing a macerated femur in anteroposterior and mediallylateral view. In *B*, two disk-like cortical defects of a diameter of 0.5 cm. and of a depth of 0.2 cm. have been produced which leave the spongy structure almost untouched. One is located at the lateral surface of the lateral condyle, the other at the posterior surface of the medial condyle. Both are filled with paraffin. *B'* depicts the same de-



Fig. 3-A. Control roentgenogram of the distal end of a macerated femur in medial-lateral and anteroposterior view. Medial condyle to the left, lateral to the right in anteroposterior view.

fects filled with opaque material. Anteroposterior and lateral films are negative for the lateral excavation; the medial one is faintly visible on lateral view. In *C*, the defects have been enlarged and deepened into the spongy layer. Their base has a diameter of 0.5 cm., their depth is also 0.5 cm. The medial defect is now visible on anteroposterior and lateral view—the lateral still cannot be demonstrated in either view. In *D*, both defects have been enlarged and deepened. Diameter of base and depth of defects is 0.75 cm. The lateral now becomes also faintly visible on lateral view. In *E*, both defects have the following dimensions: diameter of base and depth, 1 cm. The lateral is now also well marked on the lateral view, but negative on anteroposterior view. In *F*, only the lateral defect has been enlarged and filled with opaque material (since the medial was well outlined on previous films). Its base is now 1.3 cm. in diameter, its depth also 1.3 cm. It still does not show up on anteroposterior view. Enlargement of the lateral defect to 2 cm. at the base and to a depth of the same size is necessary to make it distinctly visible

also on anteroposterior view (Figs. 3-G and 3-G').<sup>3</sup>

From this experiment we come to a number of essential conclusions. Most important of all is the fact that not all osseous defects are visible on the roentgenograph in either front or profile view, but that they require a certain size in order to appear on the x-ray film. The minimum dimension necessary for visibility varies with the location of the defect. In our case we compared two excavations of identical size, shape, and volume and obtained the following results:

Defect 1 on posterior surface of medial condyle is visible at

0.5 cm. diameter of base } on profile view  
0.2 cm. depth }

and  
0.5 cm. diameter of base } on front view  
0.5 cm. depth }

Defect 2 on lateral surface of lateral condyle is visible at

0.75 cm. diameter of base } on profile view  
0.75 cm. depth }

and  
1.75 cm. diameter of base } on front view<sup>4</sup>  
1.85 cm. depth }

From the direction of the axes of the two defects one would expect Defect 2 to be visible on profile view at about the same size as Defect 1 on front view and, correspondingly, Defect 1 on profile view at about the same size as Defect 2 on front view. This would be true if certain conditions were identical in both cases, *viz.*:

- (1) The diameter of transradiated bone which is superimposed over the defects;
- (2) The relative amounts of cortex and spongy matter;
- (3) The distance of the defects from tube and film.

Inspection of the skeleton of the distal end

<sup>3</sup> A number of intervening roentgenographs with defects of gradually increasing size are not shown here.

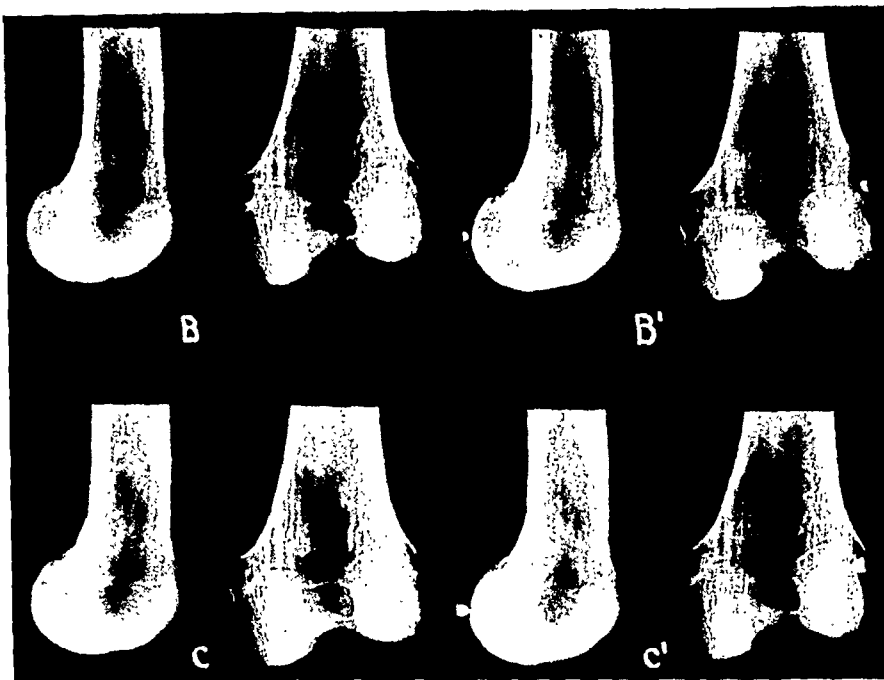
<sup>4</sup> At this size the defect was barely visible in the roentgenograph.

of the femur convinces us that this is not the case. The knee joint especially is characterized by very irregular arrangement of its parts and by very unequal distribution of cortex and spongy bone, as we have shown in a previous paper. Closer study of the site of our defects and the reasons for their different degrees of visibility enables us to realize that one excavation is located on the most posterior part of the median condyle, a portion which is not superimposed over the lateral condyle in profile view, while Defect 2 is situated in an area which in this view is overlaid completely by the other condyle. Figures 3-E and 3-E' demonstrate the importance of this superimposition. While on lateral view, part of Defect 1 in the posterior portion of the medial condyle is superimposed over the other condyle and is obscured by it, the more posterior area of the defect is distinctly visible (see arrow). Thus while *a priori* the direction of the axis of Defect 2 is more favorable in lateral view, the configuration of the bone cancels this advantage. One more important reason for the different degrees of visibility of the two defects in the medial and lateral condyle lies in the normally greater translucency of the medial condyle in anteroposterior view, the reason for which we have given in a previous paper.

Many of the problems touched upon in the experiment just described need further discussion and experimental clarification. We were especially interested in the question of the visibility of defects in relation to their size. Excavations of conoid shape involving only the spongy structure require a diameter of from 0.5 to 1.75 cm. at their circular base and a depth of from 0.5 to 1.9 cm., depending on the site and the bone involved. Figure 4-A shows, beside the barium-filled defect in the posterior part of the lateral condyle and another in the intercondyloid area which originated from previous experiments, a faint hazy translucency in the suprametaphyseal area on the anteroposterior view. The lateral view is almost negative for this defect. Figure 4-B shows the same defect filled with

barium and demonstrates the large dimensions of this excavation. The diameter at the base is 1.75 cm., the depth 1.9 cm. In

shows the lateral defect rather indistinctly on the anteroposterior view; the medial defect is shown more clearly. Both



Figs. 3-B and 3-C. Roentgenographs of the same femur as in the control Figure 3-A. Medial condyle to the left, lateral to the right in anteroposterior view. In B, two disk-shaped cortical defects of a diameter of 0.5 cm. and a depth of 0.2 cm. have been produced. One is located at the lateral surface of the lateral condyle, the other at the posterior surface of the medial condyle. Both are filled with paraffin. B' depicts the same defects filled with opaque material. Anteroposterior and lateral films are negative for the lateral excavation; the medial one is faintly visible on lateral view. In C, the defects have been enlarged and deepened into the spongy layer; their base has a diameter of 0.5 cm., their depth is also 0.5 cm. The medial defect is now visible on anteroposterior and lateral views. The lateral cannot be demonstrated in either view. C' shows defects filled with opaque material.

contradistinction to this defect, the well marked excavation in the intercondyloid area, which measures 1.25 cm. at its base and has a depth of 1.3 cm., already showed up on anteroposterior view with a diameter of 1 cm. at the base and with a depth of 1 cm.

Figures 5-A and 5-B demonstrate two defects in the proximal end of the tibia of a knee joint with all its soft parts attached.

The excavations are located in the spongy structure of the medial condyle posteriorly and of the lateral condyle anteriorly, and measure 0.8 cm. at their base, their depth being 1.1 cm.<sup>5</sup> Our figure

defects are almost invisible on the lateral view. Defects of smaller dimensions did not show up at all. After the excavations had been enlarged to 1 cm. at the base their visibility became better on the anteroposterior view, but was still limited on the lateral view.

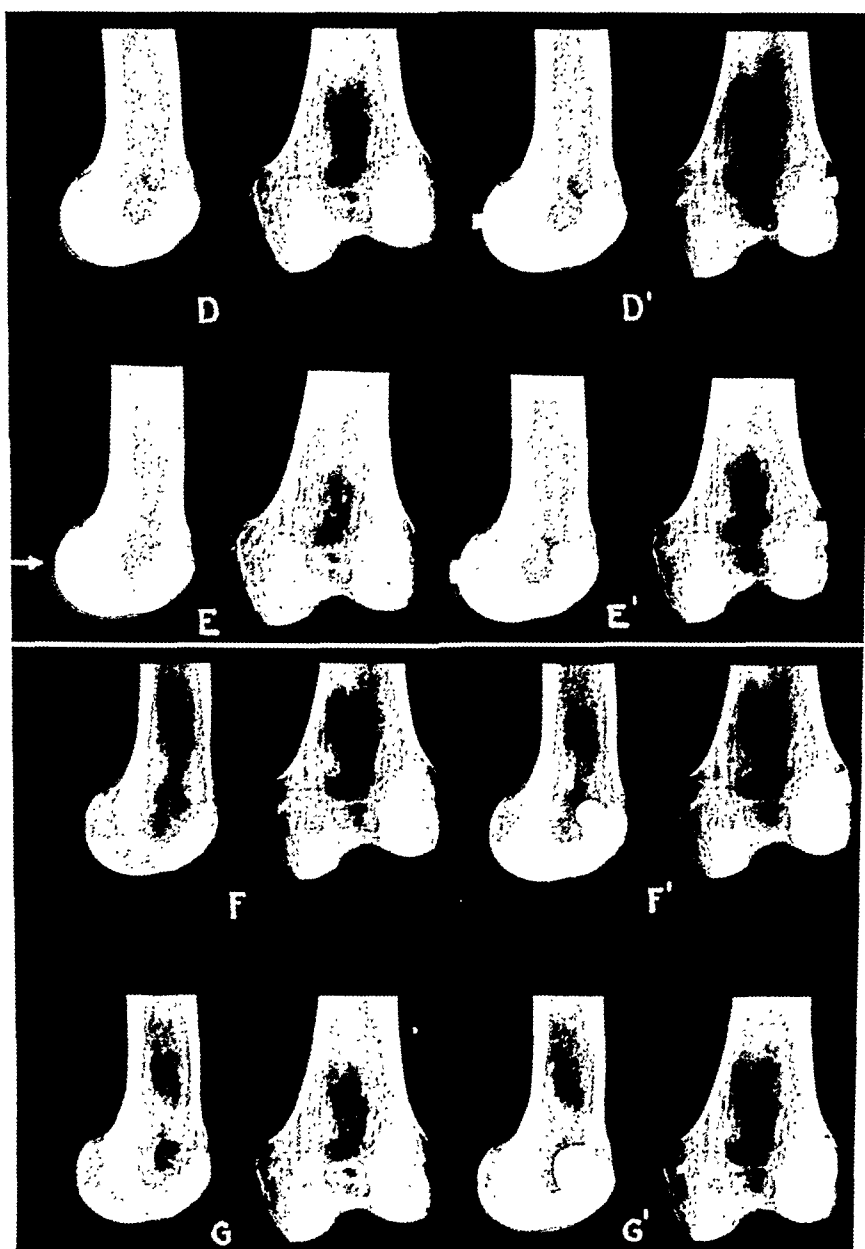
Our experiments showed that change in position of the objects so that the defects were situated close to the film did not markedly improve their visibility.

In one group of experiments we compared identical defects in two bones of different thickness. The defects were so arranged that they had the same size and position and their base was the same distance from the film. As was expected, the result showed that the defect in the

<sup>5</sup> Defects in the spongy structure of the femur condyles originated from previous experiments.

thinner bone was visible to a greater degree.

The following experiment was undertaken to illustrate the influence of osteo-



Figs. 3-D and 3-E. Roentgenographs of the same femur as in the control Figure 3-A. Medial condyle to the left, lateral to the right in anteroposterior view. In *D*, both defects have been enlarged and deepened. Diameter of base and depth of defects is 0.75 cm. The lateral is also faintly visible on lateral view. In *E*, both defects have the following dimensions: diameter of base and depth 1 cm. The lateral is also well marked on lateral view, but negative on anteroposterior view. Arrow in *E* points to the defect in medial condyle which is partly obscured by the other condyle, but well shown in its posterior portion. *D'* and *E'* depict the defects filled with opaque material.

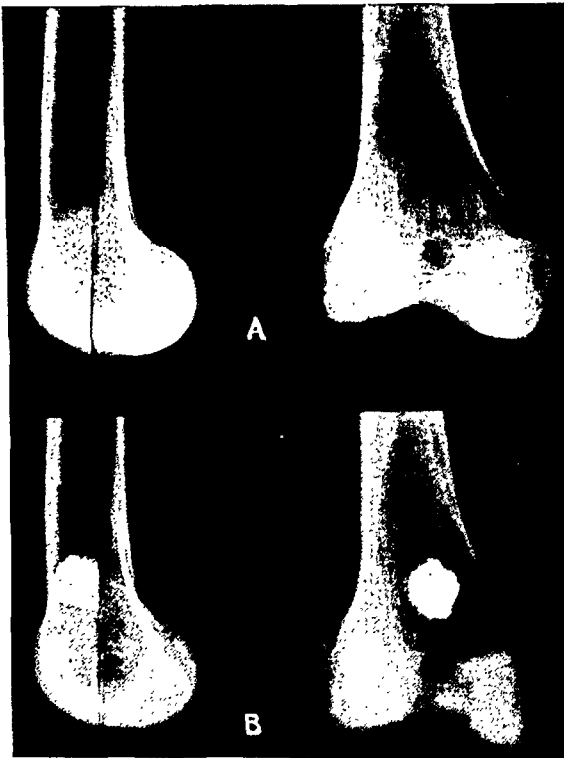
Figs. 3-F and 3-G. Roentgenographs of the same femur as in the control Figure 3-A. Medial condyle to the left, lateral to the right in anteroposterior view. In *F*, only the lateral defect has been enlarged: its base is 1.3 cm. in diameter, its depth also 1.3 cm. It still does not show up on an anteroposterior view. *G* shows enlargement of the lateral defect to 2 cm. at the base and to a depth of 2 cm. Defect is now distinctly visible in both views. In *F'* and *G'* only the lateral defect is filled with opaque material.



porosis of the surrounding bony structures on the visibility of a destruction in the spongy matter. The distal end of a macerated femur was divided in a sagittal plane into lateral and medial portions, then the medial portion was again divided in a frontal plane into anterior and posterior parts. A defect was produced in the cancellous tissue of the posterior portion of the medial condyle. It measured 0.7 cm. at the base and had a depth of 0.8 cm. The part overlying the destruction was then decalcified by chemical means. The portion containing the defect was not treated. Roentgenographs were taken at each stage. Figure 6-A is the control roentgenograph; Figure 6-B shows the bone after it was split, with the defect in

the posterior portion of the medial condyle. The destruction is almost invisible. Figure 6-C depicts the same bone after the overlying portion had been decalcified. The defect can now easily be demonstrated. The arrangement shows the importance of a surrounding osteoporosis for the visibility of destructive processes. Given the same size of a focus it will be much more visible if accompanied by osteoporosis, as is frequently the case in tuberculosis, in contradistinction to a focus surrounded by undecalcified bone as in osteomyelitis or syphilis.

A large group of our experiments comprised cortical defects. Disk-like cortical excavations were produced, filled with paraffin and a paraffin-barium mixture,



Figs. 4-A—4-B.

Fig. 4-A. Shows, beside the barium-filled defect in the posterior part of the lateral condyle and another in the intercondyloid area which originated from previous experiments, a faint hazy translucency in the suprametaphyseal area on the anteroposterior view. The lateral view is almost negative for this defect.

Fig. 4-B. Shows the same defect filled with barium and demonstrates the large dimensions of this excavation. The diameter at the base is 1.75 cm., the depth 1.9 cm.

Fig. 5-A. Demonstrates two defects in the proximal end of the tibia of a knee joint with all of its soft parts attached. The excavations are located in the spongy structure of the medial condyle posteriorly and of the lateral condyle anteriorly, and measure 0.8 cm. at their base, their depth being 1.1 cm. Defects in the spongy structure of the femur condyles originated from previous experiments. The figure shows the lateral defect rather indistinctly on the anteroposterior view; the medial defect is shown more clearly. Both defects are almost invisible on lateral view.

Fig. 5-B. Shows the same defects filled with barium.



Figs. 5-A—5-B.

gradually enlarged and roentgenographed at each stage. The defects were made as superficial as possible so that they would involve mainly the cortical structure and then were deepened into the spongy

the anterior surface of the medial condyle of the tibia, Defect 2 on the posterior surface of the lateral condyle. While the anteroposterior view is negative for Defect 1 and positive for Defect 2, the lateral

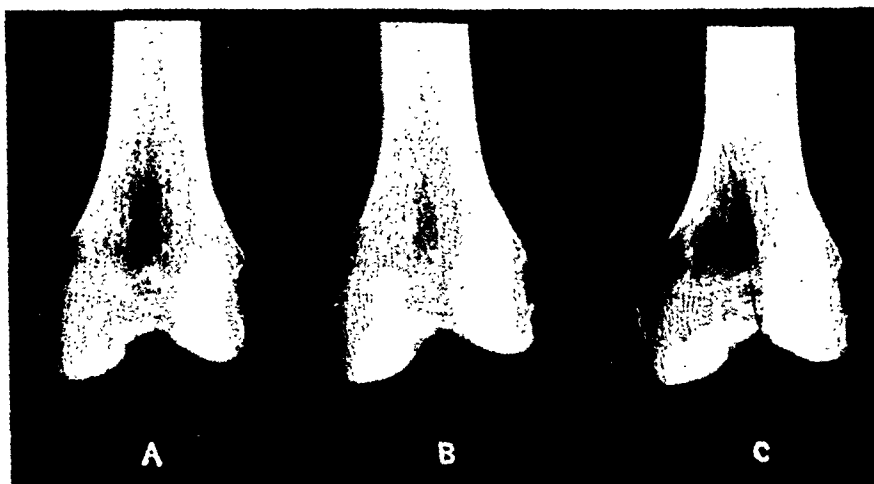


Fig. 6-A. Control roentgenograph of the distal end of a normal macerated femur.

Fig. 6-B. The bone has been divided in a sagittal plane into lateral and medial portions, then the medial portion has again been divided in a frontal plane into anterior and posterior parts. A defect has been produced in the cancellous tissue of the posterior portion of the medial condyle. It measures 0.7 cm. at the base and has a depth of 0.8 cm. The destruction is almost invisible.

Fig. 6-C. The part overlying the destruction has been decalcified by chemical means. The portion containing the defect has not been treated. The defect can now easily be demonstrated.

layer. This changed their shape from flat disks to conoids. Figure 7-B depicts three cortical defects on the medial surface of medial condyle and epicondyle. Their diameter at the base is 1 cm., their depth 0.5-0.7 cm. Figure 7-A is the control. Barium filling in Figure 7-C illustrates the size and positions of the excavations. Even by careful comparison with the control film they are barely to be detected.

Again as in the case of spongy defects our results showed that the size of a defect is less important than its position in relation to the x-ray beam. The diameter by which superficial cortical defects of equal depth could be made out in the roentgenograph varied in our experiments from 0.5 cm. to 2 cm.

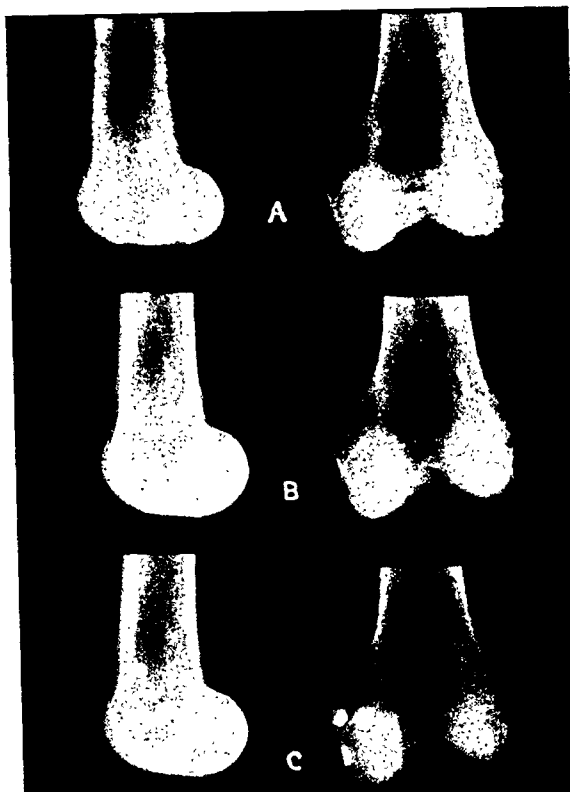
Figure 8-B demonstrates two defects, 2 cm. in diameter at the base and with a depth of 0.75 cm. Defect 1 is located on

view is negative for Defect 2 and positive for Defect 1, thus demonstrating the advantages of the combination of the two standard positions. Figure 8-A is the control; Figure 8-C shows the defects filled with barium. Previous experiments had shown that by reason of the relatively small size of the bones of the knee joint change in the direction of the x-ray beam from lateral-medial and anteroposterior to medial-lateral and postero-anterior did not produce any marked improvement in the visibility of defects.

But often two standard projections are not sufficient to reach optimum results. Destructions in the area of the intercondyloid fossa illustrate this best. Figures 9-A-9-C' depict a small excavation, 0.5 cm. in diameter at base, 0.4 cm. in depth. Lateral and anteroposterior views are almost negative for this defect, while

it is well shown by a special view which was introduced by B  cl  re and by Frik and has been described by Kaiser, Danelius and Miller, Hult  n, and Holmblad.<sup>6</sup> Analytical study of this new projection shows

anatomy of the knee joint it was pointed out that the distal anterior and posterior contours of Ludloff's spot which are noticeable on lateral view correspond to a narrow cortical zone in a plane laid through the



Figs. 7-A—7-C.

Fig. 7-A. Control roentgenograph of the distal end of a normal macerated femur.

Fig. 7-B. Depicts three cortical defects on the medial surface of medial condyle and epicondyle. Their diameter at the base is 1 cm., their depth 0.5–0.7 cm. The defects can barely be detected.

Fig. 7-C. Demonstrates the defects filled with barium.

Fig. 8-A. Control roentgenograph of the proximal end of a macerated tibia. Medial condyle to the right, lateral to the left in anteroposterior view.

Fig. 8-B. Demonstrates two defects, 2 cm. in diameter at the base and with a depth of 0.75 cm. Defect 1 is located on the anterior surface of the medial condyle of the tibia; defect 2 on the posterior surface of the lateral condyle. While the anteroposterior view is negative for Defect 1 and positive for Defect 2, the lateral view is negative for Defect 2 and positive for Defect 1, thus demonstrating the advantages of the combination of the two standard positions.

Fig. 8-C. Shows the defects filled with barium.



Figs. 8-A—8-C.

that it is especially well adapted to demonstrate changes in lateral and medial walls of the intercondyloid fossa, areas which are obscured in the standard projections. The roof of the intercondyloid fossa is best shown on an anteroposterior view.

In a previous analysis of the roentgen

center of the intercondyloid area (Fig. 10). Defects in this zone will show up as interruptions of the contours of Ludloff's spot in lateral view. Figures 11-A–11-C depict a defect in this area. Its base is 1 cm., its depth 0.5 cm. The defect is noticeable as an interruption of the distal outline of Ludloff's zone in its most anterior part (notice arrow). Even smaller destructions that the one described may be

<sup>6</sup> A defect in the metaphyseal area visible on special view originated from previous experiments.

detected in this area. But if the defect is located 1 or 2 cm. to the right or left of the middle line on the same patellar surface of the femur, then this interruption of the contour of Ludloff's zone does not take place.

Rather unfavorable for demonstration are defects on the superior articular surface of the tibia or in the anterior and posterior intercondyloid fossa of the proximal end of the same bone. If they involve only the cortex of this area they are almost always not to be detected, except when interrupting the contours of the roentgenograph. Part of the spongy structure has to be destroyed to make the defects visible. Out of the great number of experiments arranged in the condylar area of the tibia, only one may be shown (Figs. 12-A-12-C). The defect is located in the posterior intercondylar fossa. It is 1.25 cm. in diameter at the base, 1.3 cm. in depth. Exact comparison with the control (Fig. 12-A) shows only slightly increased translucency in the area involved. The experiment also demonstrates the difficulty in detecting destructive foci in regions which are normally more translucent than their surroundings.

As an example of early visibility the following defect may be demonstrated (Figs. 13-B and 13-C). It is located in the cortex of the anterior surface of the patella. Its diameter at the base is 0.5 cm., its depth 0.3 cm. The excavation is well shown on medial-lateral and postero-anterior views. We found defects of such small dimensions visible also on the femur and tibia, if they were located marginally, *i.e.*, if they led to an interruption of the contours of the roentgenogram. In this respect cortical defects on the lateral surface of the lateral condyle of the femur have a better chance to be visible than those on the medial surface of the medial condyle, since the former surface lies nearly in the plane of an anteroposterior x-ray beam, while the latter is oblique to it. Defects on the former will, therefore, more frequently be seen on edge and will

produce marginal interruption.<sup>7</sup> Our experimental studies on the intercondylar fossa and in other areas, and the facts just mentioned, have demonstrated that the more views we take of a given bone, beside the two standard projections, the better are the chances to demonstrate destructive lesions. For this reason oblique views which bring other parts of the bone in a marginal position are very helpful and should more often be employed. Generally speaking, the more complicated the outer contour of a bone the greater are the chances to overlook destructive foci.

Beside the position of the defect in relation to the central ray, the other factors determining its visibility are the amount of cortical and spongy tissue overlying it in the x-ray view and the relative share each of these two structural components has in the production of the roentgenogram, as discussed in a previous publication. It is also one more reason to take x-ray films from different angles, so as to vary the diameter and character of the superimposed structures.

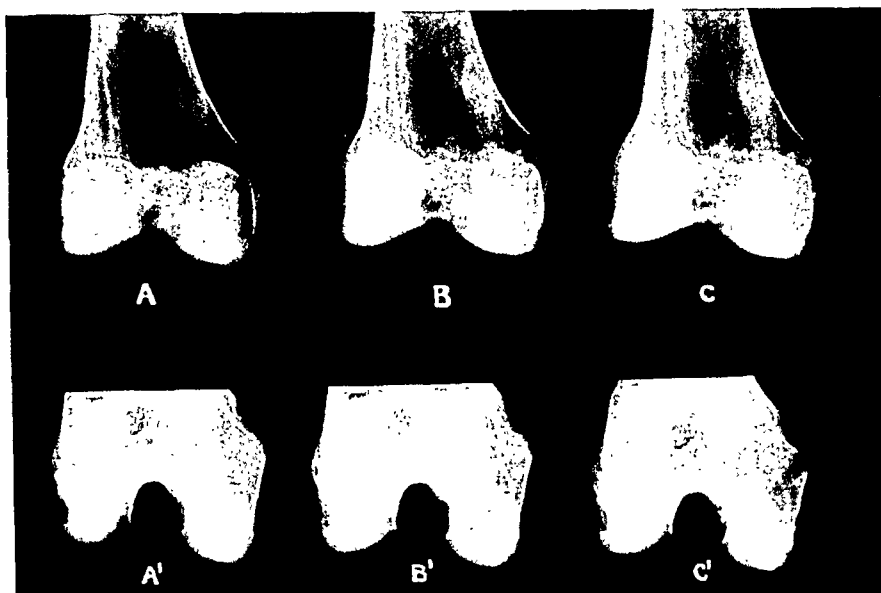
Of further importance is the character of the border of a destructive focus. If clear-cut and well defined, the chances of its being visible are greater than if hazy and indistinct. The contents of the destructive focus also play a rôle. All our defects were filled with paraffin, which has approximately the same absorption coefficient for x-rays as granulation tissue. If bone debris fill the defect, as frequently is the case in destructive foci, then the chances of its visibility are impaired. Our experiments demonstrated that an excavation becomes less readily visible if filled with a mixture of paraffin and bone dust than with paraffin alone.

It seems a worthwhile undertaking to examine the x-ray symptomatology of destructive processes of the knee joint in the light of our experiments. From the

<sup>7</sup> The defect on the lateral surface of the lateral condyle, shown in Figure 3, was too far anterior to be marginal on the anteroposterior view. It is the area around the popliteal groove and the lateral epicondyle which is responsible for the roentgenographic contour in this region.

large group of different lesions, tuberculosis, osteogenic sarcoma, and osteochondritis dissecans shall be selected. This

tremely optimistic statements on the value of the roentgenogram, such as Fraser's (who identified each of the pathologic



Figs. 9-A and 9-A'. The control roentgenographs of the distal end of a macerated femur in anteroposterior and special view. A defect in the metaphyseal area visible on special view originated from previous experiments.

Figs. 9-B and 9-B'. A small excavation 0.5 cm. in diameter at base, 0.4 cm. in depth. The anteroposterior view is almost negative for this defect while it is well shown on special view.

Figs. 9-C and 9-C'. The defect filled with barium.

promises to give us a better insight into the limitations of our method, especially for the early lesions, than comparison of roentgenograms and autopsic material, which is otherwise so valuable.

#### TUBERCULOSIS

The following authors have concerned themselves with a correlation of pathologic and roentgenologic findings in tuberculous joints: Franz Koenig, Ely, Fraser, Woldenberg, Lovett and Wolbach, Phemister, Ghormley, Fritz Koenig, Pitzen, Greig, Girdlestone, Sorrel and Sorrel-Dejerine, Ghormley, Kirklin and Brav, Phemister and Hatcher, Hellner, and Lange. Their studies are based mainly on advanced cases of bone tuberculosis and their opinions differ as to the diagnostic value of the x-ray method as an aid in the early diagnosis and differential diagnosis of tuberculosis. Ex-

varieties of joint tuberculosis on the roentgenogram), can be contrasted with others pointing out that "there may be extensive bony involvement by tuberculosis without any appreciable change in the x-ray picture" (Ghormley), or that "there exists no roentgen picture that is entirely typical of joint tuberculosis in any of its stages" (Sundt). On the whole the skeptics predominate. Fritz Koenig states that one cannot practise pathologic anatomy with the roentgen plate and cannot obtain from it complete information on pathologic changes in the same way as is offered on the operating or autopsy table. As an example of over-estimation of the possibilities of the roentgenogram, the following sentences from Fraser's book on "Tuberculosis of the Bones and Joints in Children" may be quoted:

"The original marrow tubercle appears in the negative as a rounded light point. The

detected in this area. But if the defect is located 1 or 2 cm. to the right or left of the middle line on the same patellar surface of the femur, then this interruption of the contour of Ludloff's zone does not take place.

Rather unfavorable for demonstration are defects on the superior articular surface of the tibia or in the anterior and posterior intercondyloid fossa of the proximal end of the same bone. If they involve only the cortex of this area they are almost always not to be detected, except when interrupting the contours of the roentgenograph. Part of the spongy structure has to be destroyed to make the defects visible. Out of the great number of experiments arranged in the condylar area of the tibia, only one may be shown (Figs. 12-A-12-C). The defect is located in the posterior intercondylar fossa. It is 1.25 cm. in diameter at the base, 1.3 cm. in depth. Exact comparison with the control (Fig. 12-A) shows only slightly increased translucency in the area involved. The experiment also demonstrates the difficulty in detecting destructive foci in regions which are normally more translucent than their surroundings.

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Of further importance is the character of the border of a destructive focus. If clear-cut and well defined, the chances of its being visible are greater than if hazy and indistinct. The contents of the destructive focus also play a rôle. All our defects were filled with paraffin, which has approximately the same absorption coefficient for x-rays as granulation tissue. If bone débris fill the defect, as frequently is the case in destructive foci, then the chances of its visibility are impaired. Our experiments demonstrated that an excavation becomes less readily visible if filled with a mixture of paraffin and bone dust than with paraffin alone.

It seems a worthwhile undertaking to examine the x-ray symptomatology of destructive processes of the knee joint in the light of our experiments. From the

<sup>7</sup> The defect on the lateral surface of the lateral condyle, shown in Figure 3, was too far anterior to be marginal on the anteroposterior view. It is the area around the popliteal groove and the lateral epicondyle which is responsible for the roentgenographic contour in this region.

Changes in the width of the roentgenologic joint space will express themselves as widening or narrowing of the joint fissure. It is surprising how great is the number of early cases of knee joint

ranz, will often not be discernible or cannot be differentiated from peri-articular swelling. The latter will lead to an apparent increase in the width of the joint fissure due to an increase in the distance of the

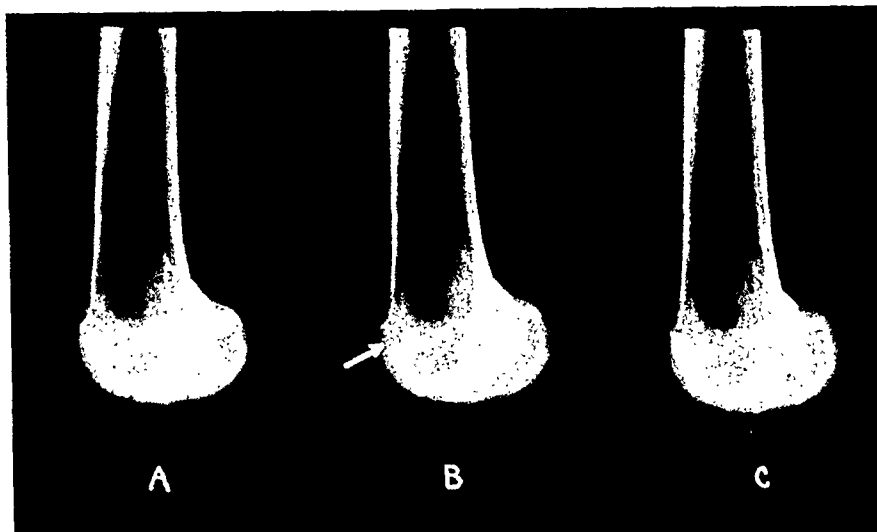


Fig. 11-A. Control film of the distal end of a macerated femur.

Fig. 11-B. A defect as an interruption of the distal contour of Ludloff's zone in its most anterior part (see arrow). The base of the defect is 1 cm., its depth 0.5 cm.

Fig. 11-C. Demonstrates the defect filled with barium.

tuberculosis in which there is no alteration in the width of the joint space (Schinz). In previously described experiments on unembalmed fresh cadavers we tried to determine the amount of fluid necessary to produce a raising of the patella from its bed on the femur. If we measured the distance between certain points on the patella and femur which can easily be identified, we found that an injection of 20 c.c. increases the distance between these given points by 0.2 cm.; of 40 c.c. by 0.3 cm.; 60 c.c. by 0.5 cm. This could be demonstrated only by very exact comparison with the healthy knee, a comparison which would be rendered impossible by swelling of the peri-articular structures on the diseased side. According to Borak and Goldhamer, clinical ballottement of the patella can be demonstrated by filling the joint with 40 c.c. of fluid. The roentgenologic sign of clouding of the joint space, which has been described by Pome-

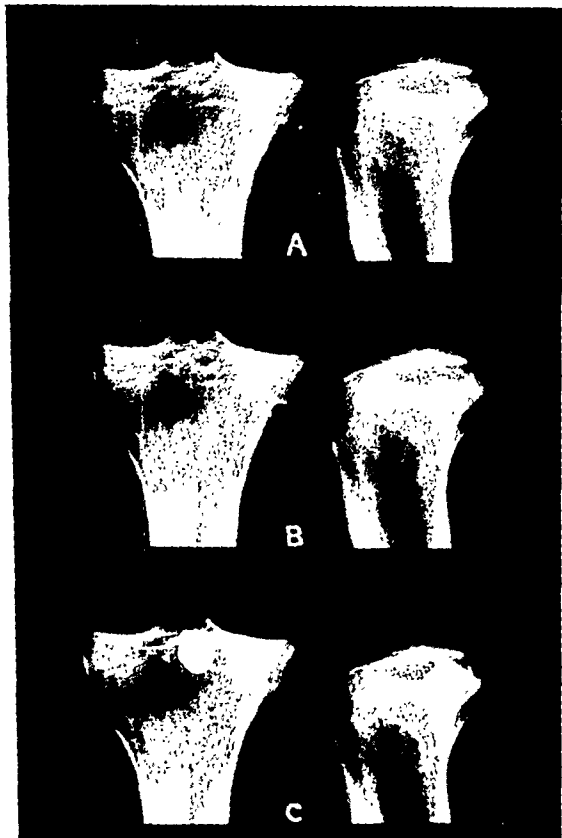
object from the film. To understand the limitations of the x-ray sign of widening of the joint space produced by an intra-articular exudate we have to keep in mind that the exudate will first fill all the recessus of the joint cavity before it will bring about a separation of the articulating bones. The non-specificity of a roentgenologically demonstrated exudate will be discussed later.

Narrowing of the joint fissure is a sign of destruction of the cartilage. According to Schinz, the width of the so-called joint space in the roentgenogram of the knee joint varies normally from 4 to 8 mm., so that small narrowing of the fissure due to destruction of cartilage may still be within the normal limits. Ghormley, Kirklin, and Brav call attention to the fact that changes in the position of the knee may cause modification of the roentgenographic appearance of the intra-articular area. The greater the flexion, the narrower will

be the representation of the joint space on the film, regardless of the amount of cartilage remaining. The joint fissure is also at least 1.5 mm. narrower in the upright than in the horizontal position (Popovic

subchondral granulations after the cartilage has been detached.

In regard to all changes in the knee joint which do not involve bone, it is wise to keep in mind that the roentgenogram is



Figs. 12-A—12-C.

Fig. 12-A. Control film of the proximal end of a macerated tibia.

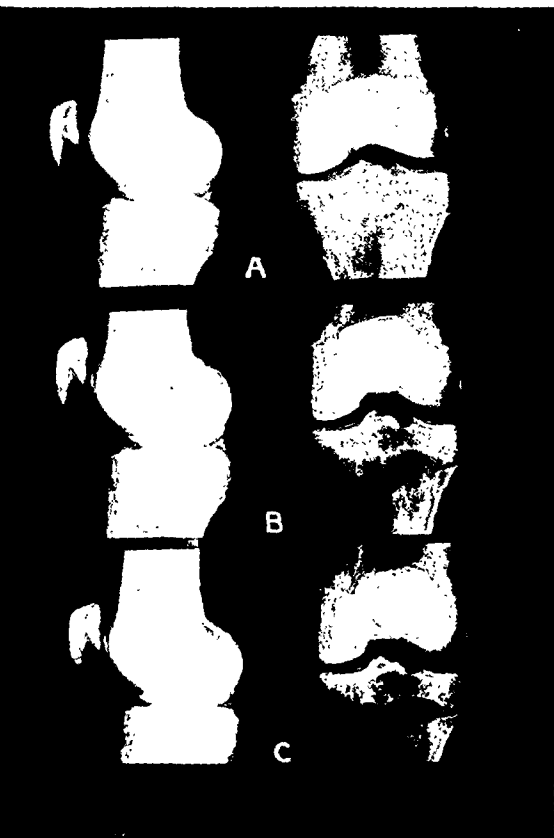
Fig. 12-B. Demonstrates a defect in the posterior intercondylar fossa, 1.25 cm. in diameter at the base, 1.3 cm. in depth. The film shows only slightly increased translucency in the area involved.

Fig. 12-C. Shows the defect filled with barium.

Fig. 13-A. Control film of a normal knee joint.

Fig. 13-B. Demonstrates a defect in the cortex of anterior surface of patella. Its diameter at the base is 0.5 cm., its depth 0.3 cm. The excavation is well shown on medial-lateral and postero-anterior view.

Fig. 13-C. Shows the defect filled with barium.



Figs. 13-A—13-C.

and Doric). Control films of the normal side should always be taken with the knee in the same position as that on the diseased side. Narrowing of the joint fissure is not an early sign of knee joint tuberculosis (Phemister, and Phemister and Hatcher). According to these authors, the loosened articular cartilages may persist for many months, due to the absence of proteolytic ferments in the tuberculous exudate and to the slow rate of attack and absorption of cartilage by the

a very inaccurate indicator. We have to realize that a knee joint which appears absolutely normal on the film may be filled with numerous granulations which penetrate the cartilage without attacking the bone. Hellner often did not find any signs of involvement of the joint on the roentgenogram, in cases in which the operation showed a partly tuberculous, partly non-specific pannus covering the cartilage.

Bone atrophy is frequently given as one



of the characteristic signs of early tuberculosis. Schinz, for instance, points out that secondary osteoporosis is often the only symptom of early tuberculosis: there will be smooth bone structure, normal

width of the joint space, and no changes in the contours of the joint combined with marked decalcification. In fact, many authors have found this symptom-complex rather pathognomonic for tuberculosis.

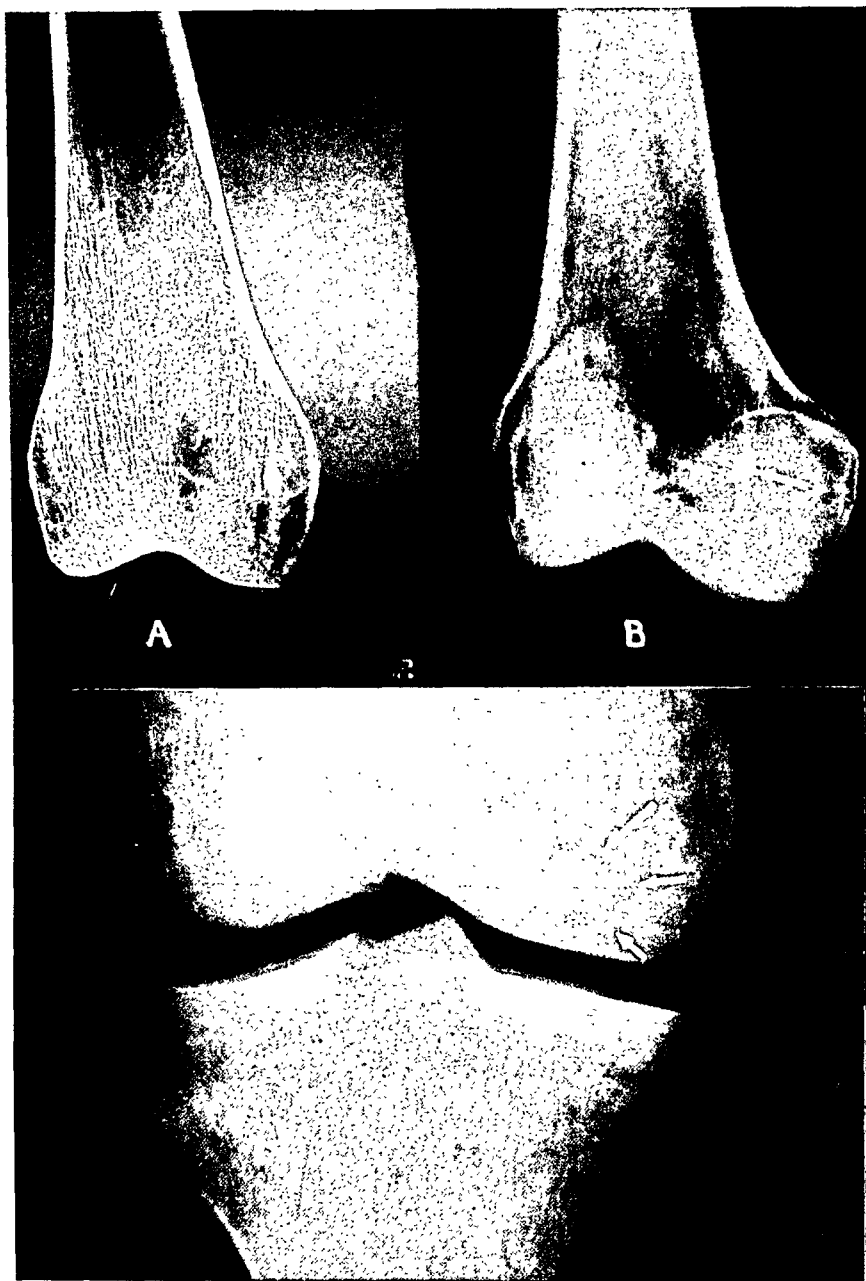


Fig. 14-A (above). Roentgenogram of a thin section of the distal end of a macerated femur showing a circumscribed area of sclerosis, a compact island.

Fig. 14-B (above). Roentgenogram of a femur containing the section shown in Figure 14-A. The compact island is almost invisible (see arrow).

Fig. 15 (below). Roentgenogram of an osteochondritis lesion in a fairly early stage. The necrotic bone fragment is surrounded by a more translucent zone of demarcation (see arrow).

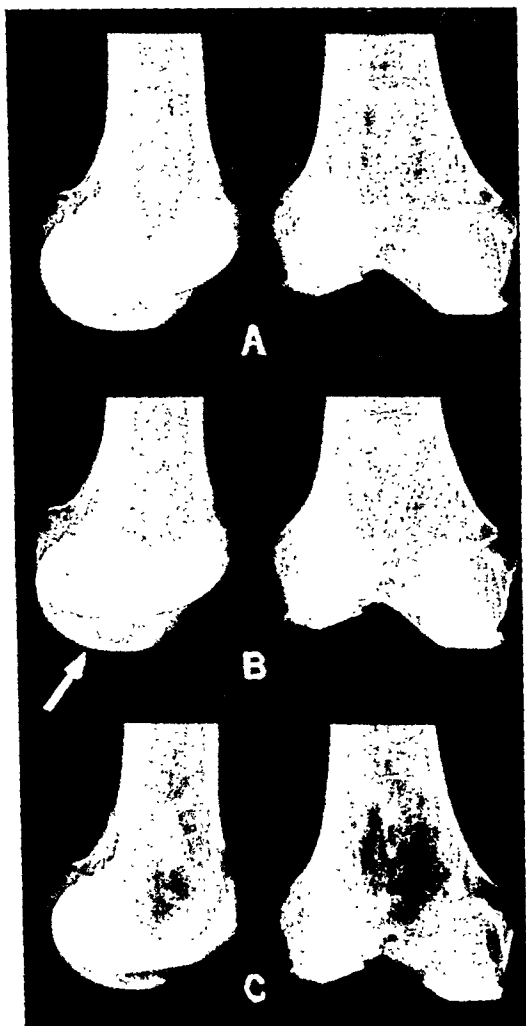


Fig. 16-A. Roentgenogram of the distal end of a macerated femur.

Fig. 16-B. A wedge-shaped piece of bone has been cut out from the medial condyle at approximately the typical position, replaced and roentgenographed. The anteroposterior view is negative; the lateral shows the demarcation barely outlined (see arrow).

Fig. 16-C. The gap surrounding the fragment has been filled with barium so that the defect and the fragment are well outlined.

And yet we know of numerous cases of tuberculosis of the knee joint in which osteoporosis was not present in early stages. (Schiller and Altschul, Pomeranz). Heller states very truly that atrophy in itself is a roentgen sign which speaks neither for nor against tuberculosis.

In a previous paper (Lachmann and Whelan) it was demonstrated by decalcification experiments on bones that there are

marked limitations to the x-ray diagnosis of osteoporosis. Only under very favorable circumstances can decalcification below 20 per cent be diagnosed. In most bones the calcium loss, in order to be visible, must be in the vicinity of from 20 to 40 per cent. Furthermore, it was shown by these experiments that the amount of decalcification necessary for diagnosis varies considerably in different bones and in different parts of the same bone. While the bones forming the knee joint, due to their structural composition, are rather favorable for demonstration of bone atrophy, it seems doubtful whether a decalcification of less than 20 per cent of the total calcium present would show up on the film. In the light of the above mentioned experiments, any statements which describe bone atrophy as starting in a certain area and spreading in a certain direction are on weak ground if they are based on x-ray studies only.<sup>8</sup> The value of established osteoporosis for the diagnosis of joint tuberculosis will be discussed later, together with the differential diagnosis.

Bone destruction is, of course, the most important sign of a knee joint tuberculosis. In the material of Ghormley, Kirklín, and Brav, 86.1 per cent of the roentgenograms of verified cases of tuberculosis of the knee joint disclosed definite destruction of bone. It is here that the experiments which have been described above will be most helpful in determining the limitations of the x-ray method.

The position of the primary osseous focus varies. According to pathologic studies (Konschegg), it may be located either in the epiphysis itself, more or less distant from the joint cartilage, or in the metaphysis reaching into the diaphysis. It is supposed to be more frequent in the distal epiphysis of the femur than in the proximal end of the tibia (Pouzet), and

<sup>8</sup> For instance, the following statement by Pomeranz: "In the knee this process [osteoporosis] occurs most commonly in the femoral epiphysis, particularly externally and posteriorly, whereas the tibial condyles, while they take part in the disease, appear to be affected later in the process."

may also occur in the patella (Blumensaat). The pathologists differentiate two types with transitions (Konschegg, Randerrath, Max Lange). The first type, the granulating (fungous) tuberculosis is char-

acterized by the expression of this type of a tuberculous lesion. In later stages of the disease both types are often represented, or we find transitional pictures. Secondary involvement of the joint occurs in both forms



Fig. 17. A fragment of bone consisting of cortical and spongy substance has been detached from the medial condyle of one femur of a cadaver and placed in the knee joint of the other in front of the medial condyle. This knee joint is depicted in this figure after it has been opened up and closed with as little damage as possible. The fragment is well outlined on lateral view (see arrow), but is invisible on antero-posterior view.

acterized by the formation of granulations which produce early destruction of bone trabeculae and thus lead to formation of a bone cavity which is filled with tuberculous granulations or necrotic debris. The second type, the caseous form, leads to early necrosis of bone trabeculae, but caseation of tuberculous tissue results before the enclosed bone trabeculae are destroyed (Lange). Within the caseous masses the more or less preserved bone trabeculae are necrotic, but not altered in their structure (Schinz). A wedge-shaped area of necrosis with the base directed toward the joint or the periphery of the bone may be

From this description we realize that the productive granulating type will produce earlier changes in the roentgenogram than the caseous exudative. According to Schinz, it takes about three months or more before a tuberculosis of the skeleton will produce visible changes on the x-ray film. Our experiments show the reason. Destructive foci have to reach a certain size before they are visible, the dimensions varying with the location of the focus and the relation of its longest axis to the direction of the x-ray beam. It may be recapitulated that conoid-shaped spongy defects must be 0.5 to 1.75 cm.

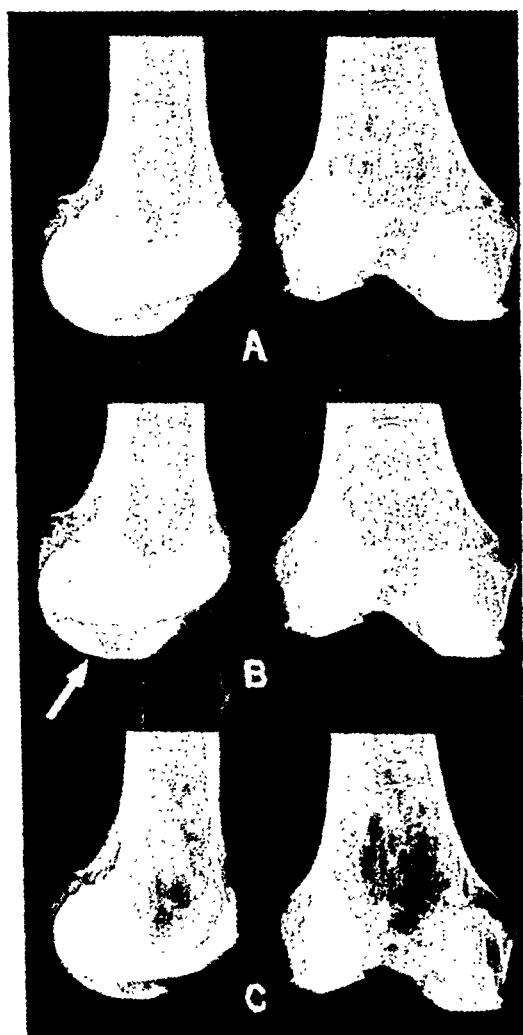


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focus of destruction (Kopstein, Blumen-saat). Köhler mentions cases without any atrophy with quite definite and sharply delimited translucent foci. This is the type we tried to imitate with our experiments (Figs. 1-A and 1-B). Spongy defects were visible when they reached a diameter of from 0.5 to 0.75 cm. at the base and a depth of from 0.5 to 0.75 cm. Cortical defects of 0.5 cm. in diameter and 0.3 cm. in depth could also be demonstrated. Attention should be called to a normally more translucent area at the apex of the bone, which is frequently also the site of early tuberculosis (Franz Koenig).

It has been pointed out above that, especially in the caseous type, we may encounter large foci of necrotic bone which cannot be detected as such on the roentgenogram. This is the case if the decalcified ring of demarcation is so narrow that it cannot be made visible (Schinz, Pomeranz), or if the sequestrum is formed after considerable atrophy has taken place (Phemister). In this event there will not be any noticeable difference in the density of the vital and necrotic bone. Ghormley, Kirklin, and Brav, who tested the accuracy of the roentgen method in showing up sequestra, compared the films and gross specimens of cases of tuberculosis of the knee joint which definitely showed bony sequestra. In 35 per cent the roentgenogram demonstrated the lesion present, but in 65 per cent it failed to show the exact condition although in some cases with more than one sequestrum the error was only partial.

While cyst-like tuberculous bone cavities, as they have been described in detail by Kienböck, and in the American literature by Elliott, can usually be detected on the film, they may escape detection, as our experiments show, if they are small or unfavorably located, especially if they are filled with bone débris. Wells and Long, in "The Chemistry of Tuberculosis," point out that calcified necrotic masses in tuberculosis resemble bone ash in their proportions of calcium and magnesium phosphate and carbonate. Greig described minute

spicules of the fragments of trabeculae which escape decalcification and can be found as fine, gritty particles in the caseous masses. This we tried to imitate in our experiments by filling the excavations with a mixture of paraffin and bone dust. The result was that the defects became less visible if they contained bone detritus than if they were filled with paraffin alone.

Model experiments on cadavers as well as clinical experience has taught us that all x-ray signs which have been given as characteristic for early tuberculous lesions have their pronounced limitations.<sup>9</sup> It has become especially clear that a negative roentgenogram does not exclude the possibility of tuberculosis of the joint.

Given these limitations, the x-ray method is, compared with other diagnostic procedures, still one of the best means to follow the course of the disease and to demonstrate its advance, standstill, or cure. But here also we have to make certain reservations. Attention has been already drawn to the fact that the roentgenogram does not allow any reliable conclusions as to the starting point of the disease; it has further been pointed out that, in the presence of a bony focus, negative findings in the joint itself do not establish the synovial cavity as free from involvement (Girdlestone), and *vice versa*. These facts thus limit the possibilities of arriving at a correct prognosis from the x-ray film alone. While atrophy in itself is a fairly reliable sign of activity of a process, lack of atrophy in presence of bone destruction does not prove healing (Hellner). Other limitations can be derived from the fact that not every sequestrum can be seen in the roentgenogram and that reactive processes as osteosclerosis and periostitis, are not necessarily expressions of a superimposed streptococcal or staphylococcal infection (Reinberg, Lovett and Wolbach, Pitzen, Pomeranz). Pitzen describes a tuberculous focus of the planum popliteum with marked periosteal reaction.

<sup>9</sup> Rarer signs, *i.e.*, productive processes and deformities, have been excluded from this discussion.

This leads us to the last point of this discussion: Are the classic roentgenographic signs of knee joint tuberculosis pathognomonic for this disease? From clinical experience this question can be answered in the negative. Smith reports 63 cases of chronic joint disease suspected of being tuberculosis, which came to operation, and in 39.7 per cent of these tuberculosis was not present (quoted from Elliott). Sundt found that in 61 cases operated on for probable tuberculosis of the knee joint, 48.4 per cent were non-tuberculous. While the diagnosis in these cases was based on all evidence at hand, we may assume that the roentgenogram played an important part. It is, of course, not one x-ray finding in itself, but a combination of signs which is supposed to establish the roentgen diagnosis of knee-joint tuberculosis. Rarely will the whole group of so-called classic signs be present, and combinations of x-ray symptoms in cases of tuberculous gonitis can be matched by x-ray findings which prove to be non-tuberculous.

A frequent roentgen finding which is often a diagnostic puzzle is marked atrophy of all bones forming the joint, combined with signs of an exudate and thickening of the capsule. The atrophy is either patchy and the bone texture blurred or diffuse and homogeneous and the individual trabeculae well defined, depending on the acuteness of the pathologic process. Neither one of these findings is pathognomonic for tuberculosis. Friedrich, Burckhardt, Lotsch, Sundt, and Hellner have concerned themselves with a study of these cases and call attention to the frequent occurrence of a chronic unspecific synovitis, "pseudotuberculosis" (Friedrich). According to these authors, the chronic hydrops genu offers one of the most difficult diagnostic problems. Friedrich believes that the possibilities of the roentgenogram in the diagnosis of these joint lesions are highly overestimated. Burckhardt gives the relation of frequency of incidence of non-tuberculous to tuberculous synovitis as 50:50 (quoted from

Hellner). Marked decalcification is not always present in tuberculosis and both types of osteoporosis can be found also in non-specific gonitis (Friedrich). Sundt points out that even under bioptic control it is often impossible to differentiate the unspecific from the tuberculous process with the naked eye. All types of non-tuberculous infections including syphilitic (Sundt) and gonorrheal (Kisch), as well as subacute and chronic post-traumatic hydrops (Breitlaender), may imitate very closely the roentgenogram of tuberculous synovitis.

If the destruction of the joint progresses and leads to necrosis of cartilage, the resulting narrowing of the joint space is in no way typical of tuberculosis. On comparing the roentgenograms of the tuberculous and non-tuberculous cases, Ghormley, Kirklin, and Brav found that as a rule in non-tuberculous cases there was more rapid and extensive narrowing of the joint space for a given duration of disease. Certain definite exceptions, however, were noted, so that this form of differentiation was by no means conclusive. The same authors likewise point out that the site of the greatest destruction can in no way be used as a differentiating feature, as was shown by their comparative studies on autopsy material and roentgenograms.

Another differential diagnostic problem is a fairly round destructive focus in the spongy matter of the distal end of the femur or the head of the tibia with or without slight sclerosis around the cavity and with or without periosteal reaction. The bone in the neighborhood does not show any atrophy. Kienböck has given an extensive description of these lesions in tuberculosis and has called them *Epiphysenfugencysten*. They are, on the whole, rather benign and produce only mild clinical symptoms, but may perforate into the joint (Kienböck, Lange). In the American literature, Elliott and also Sundt have described similar cyst-like lesions of tuberculous origin in the knee joint which appeared under the picture of *ostitis fibrosa cystica*. With Holmes and Ruggles

and others, we must say that there is nothing in the manifestations of these lesions to distinguish them from any low grade infection. Bland osteomyelitis under the picture of Brodie's abscess (Reinberg, Sorrel and Sorrel-Dejerine), as well as syphilis in its different forms must be taken into account. Parasitic (Kienböck) and traumatic cysts and primary and secondary tumors may produce similar pictures.

Summarizing our findings in this respect we can say that the following statement by Sundt is amply supported by clinical facts: "There exists no roentgen picture that is entirely typical of joint tuberculosis in any of its stages."

#### OSTEOGENIC SARCOMA

The bones forming the knee joint constitute one of the favored sites of osteogenic sarcoma. According to Kolodny, 72 per cent of all cases of osteogenic sarcoma are found in the lower extremity, 82 per cent of which affect the region about the knee, *i.e.*, femur or tibia. The femur and tibia have the highest frequency of involvement (more than 70 per cent of all cases). The site of predilection in both bones is the metaphysis adjacent to the knee joint (Kolodny).

In discussing the roentgen diagnosis of osteogenic sarcoma of the knee joint and its limitations, we have to ask ourselves: Can this affection be present with negative roentgen findings? Does the roentgenograph give us a true picture of the extent, character, and progress of the lesion? Are the roentgen signs of osteogenic sarcoma characteristic for this affection?

Since the x-ray film furnishes the surgeon with the main indication for surgical interference, it will very rarely be possible to contrast positive autopsic findings with a negative roentgenogram. But from the study of the course of typical, later autopsically controlled, osteogenic sarcomas we know that there is frequently a first stage with clinical symptoms while the roentgenogram does not reveal any pathology. If we try to express our concep-

tions of the early pathology of osteogenic sarcoma in terms of roentgenographic manifestations we realize that there will be a stage in every sarcoma that will necessarily escape roentgen diagnosis. A very instructive case of a fibrosarcoma of the lower end of the femur which showed no roentgenographic changes three months after onset of clinical symptoms but depicted marked signs of bone destruction and bone proliferation eight months later, is shown by Hodges, Phemister, and Brunschwig in Ross Golden's "Diagnostic Roentgenology."

Our above described experiments imitating destructive lesions as well as clinical experiences have demonstrated that foci may far exceed microscopic dimensions before they become possible of detection on the film. Our experiments have furthermore shown that visibility of destructive foci will depend not only on their size but also on their location in cortical or spongy bone, their relation to the central x-ray beam, the character of their margin, whether clear-cut or ill defined, sclerotic, decalcified or of normal density, on the density of the tumor itself which produces the osseous defect, and on the calcium content of the bone in the neighborhood. Since the destructive focus produced by the malignant tumor is usually not sharply delimited, the figures for earliest visibility established by our experiments are probably too low for the sarcomatous type of destruction. In all these considerations one should not forget, as Schinz has pointed out, that the parenchyma of the tumor, as long as it is not calcified or ossified, casts a shadow having the density only of soft structures and is, therefore, not directly visible.

Not accessible to our experimental approach, but also of great importance for early diagnosis are proliferative and reactive processes. But since the early changes of osteogenic sarcoma are frequently those of bone destruction only, we cannot expect the reactive processes in all cases to be present from the beginning.

But even in cases in which there is early

proliferative reaction leading to osteosclerosis, this may escape the roentgen diagnosis. While we did not have any means to imitate osteosclerosis artificially, chance helped us. In Figure 14-A we see a thin section of the distal end of the femur showing a circumscribed area of sclerosis, a so-called compact island. In the roentgenogram of the femur containing this section (Fig. 14-B) the compact island was barely recognizable. By analogy we are justified in assuming that if osteosclerosis is not very extensive, it may escape detection on the roentgenogram. Clinical experiences mentioned by Hertzler point in the same direction. He found that in cutting into an early periosteal tumor spicules of bone may be perceptible that did not show in the x-ray film. If bone sclerosis is visible it will frequently not be possible to distinguish roentgenologically between bone produced by the tumor itself and non-tumorous reactive ossification.

Practical experience in osteosarcoma has taught us to realize that the tumor is usually larger than the x-ray film shows. "The tumor is in advance of the bone changes which can be indicated radiographically" (Brailsford). Hertzler calls attention to the fact that the surgeon by gentle manipulations may cause fracture in cases in which the x-ray did not show such an extensive bone destruction. Kolodny lays great emphasis on the fact that tumors which appear roentgenographically to be entirely periosteal may involve the medullary cavity and *vice versa*. He has seen cases in which the medullary cavity was literally stuffed with tumor from end to end, while the roentgenograph indicates a tumor wholly limited to the area of involvement of the cortex and periosteal reaction. "The shaft of a bone surrounded by an osteogenic sarcoma and appearing normal in the roentgenogram is not to be considered free of involvement; a tumor may show up well around a bone, which casts a normal appearing shadow despite an extensive involvement of the haversian system and medullary cavity"

(Kolodny).<sup>10</sup> The application of these experiences for the surgeon in selecting the site of amputations in osteosarcoma is evident. For the same reasons it will be impossible to base classification of osteogenic sarcoma in periosteal and medullary types on x-ray evidence alone (Kolodny). Kolodny also stresses the fact that the greatest care should be exercised in the prognostic evaluation of the roentgenologic evidence. The statement that the bone-forming type has a better prognosis than the osteolytic may lead to many disappointing fallacies.

In discussing the roentgenologic differential diagnosis of osteogenic sarcoma of the knee region we must realize that there is no individual sign which is absolutely pathognomonic for this affection. Inflammatory processes and secondary malignancies may sometimes offer one or the other of these manifestations, which commonly have been regarded as typical for osteogenic sarcoma. Experienced observers of the roentgenologic semiology of sarcoma have stressed this fact (Codman, Geschickter and Copeland, Kolodny, Putti, Schinz). "A bone reacts against a tumor in the same way that it does to destructive stimuli which are non-neoplastic" (Putti). The two most characteristic x-ray signs of osteogenic sarcoma, the triangular lipping of the periosteum and the formation of radiating bone spicules, can be observed also in chronic infections of the bone, in metastasis, and subperiosteal hemorrhages. They are an expression of an unspecific reaction of the periosteum. The sun-ray arrangement of the newly formed bone was found in only 18 per cent of the cases of osteogenic sarcoma of the Registry material (Kolodny). The periosteal reactions of chronic osteomyelitis and of bone syphilis, together with the accompanying bone destruction, may easily be mistaken for neoplastic changes. Trau-

<sup>10</sup> On the other hand, the accompanying bone atrophy may obscure the extent of the tumor in the opposite sense. In osteolytic sarcoma the tumor may be less extensive than the x-ray suggests (Watson-Jones and Roberts).



matic myositis ossificans may closely imitate osteogenic sarcoma (Coley). In Singleton's group of primary malignant tumors the confusion of inflammatory lesions with newgrowth was responsible for about 50 per cent of the erroneous roentgenologic diagnoses. In infective arthritis of the knee joint the accompanying bone atrophy may imitate the irregular bone destruction of osteogenic sarcoma, and in the early stages the differentiation is often difficult (Singleton). Summarizing our brief differential diagnostic discussions, we may state that while the roentgen method is still best to demonstrate the pathology of osteogenic sarcoma without surgical interference, it is unable to furnish us with findings which are absolutely pathognomonic for osteogenic sarcoma.

#### OSTEOCHONDRITIS DISSECANS

In a last group of experiments the roentgen symptomatology of osteochondritis dissecans of the knee joint was approached. The lesion has its favored site on the lateral aspect of the medial condyle of the femur in close proximity to the insertion of the posterior cruciate ligament (Mueller, Walter). Without going into the details of the etiology and pathology which are still a matter of dispute, it is worthwhile for the understanding of the x-ray pathology to take notice of different stages of the disease corresponding to the extent of the lesion and the degree of sequestration of the fragment (Conway). With Köhler, we may assume that the disease is probably, at first, latent for years without causing any clinical symptoms. The pathologic finding in this stage would be a circumscribed bony necrosis, perhaps larger than the future sequestrum (Axhausen). The necrosis of the osseous tissue could be demonstrated only microscopically; roentgenologic as well as gross anatomical study of the bone would lead to negative results. At a later phase the necrotic fragment would be separated from its surroundings by a layer of fibrous tissue and fibrocartilage, while the articular cartilage covering it remains intact with the rest of the car-

tilaginous surface of the joint (Köhler, Axhausen). It is this stage which produces the first roentgen symptoms and with which we are concerned in our experiments. Figure 15 shows the roentgenogram of an actual osteochondritic lesion of this type. While the necrotic bone fragment appears only slightly more dense than its environment, it is essentially the more translucent zone of demarcation which makes the necrotic focus recognizable. Thus we realize that it depends mainly on the width and the position of this radiotranslucent ring whether the affection will be visible at this stage or not.

Again we attempted to approach this problem by model experiments imitating the affection as closely as possible. Figure 16 demonstrates the result. *A* is the roentgenogram of the macerated bone which is otherwise untreated. In *B*, a wedge-shaped piece of bone has been cut out from the medial condyle at approximately the typical position, replaced, and roentgenographed. The anteroposterior view is negative; the lateral shows the demarcation barely outlined. In *C*, the gap surrounding the fragment has been filled with barium so that the defect and the fragment are now well outlined. This experiment was repeated several times on different femora with the same result. When the line of demarcation, which always corresponded to the thickness of the saw blade, did not exceed one millimeter, the front view was always negative and the side view gave only a faint and interrupted outline of parts of the fissure surrounding the fragment. From these experiments we come to the conclusion that there are limitations to the roentgen diagnosis of osteochondritis dissecans at this phase of the lesion. The possibilities of showing the zone of separation at this stage roentgenologically are further limited by the fact that it may be filled with bony debris (Axhausen) which would obscure the fissure.

As the resorption of osseous tissue progresses the line of demarcation widens and will now make its appearance on the x-ray

film. It is wise to use stereoscopic and special views as recommended by Hodges, Phemister, and Brunschwig. Occasionally the dissected fragment consists only of cartilage, perhaps with a small attached bony lamella. In this case it cannot be detected by x-rays (Schinz). In advanced stages the fragment is displaced from its bed and may lie anywhere in the joint cavity. Schinz calls attention to the fact that it is sometimes not possible to detect the site on the femur from which the fragment originated. In order to find fragments which have been separated from their bed, as many views as possible should be used. That even large osseous loose bodies may escape visualization in one projection is shown in Figure 17. Here a fragment of bone of the usual size consisting of cortical and spongy substance was detached from the medial condyle of one femur of a cadaver and placed in the knee joint of the other side, which had been opened up and closed with as little damage as possible. Then x-rays in the two standard positions were taken. While the fragment is well outlined on lateral view it is invisible on anteroposterior view.

The roentgenogram of later stages of osteochondritis dissecans is usually typical, but the author recalls a case in which all the x-ray signs pointed to the diagnosis of osteochondritis and yet biopsy proved it to be tuberculosis. Ghormley reports a similar case. Thus even in a disease the diagnosis of which seems to be within the exclusive domain of the roentgenologist, we arrive at the conclusion that there are stages which may escape x-ray visualization and that other affections may simulate its x-ray signs.

#### SUMMARY

1. Based on a previously published analysis of the roentgenogram of the normal knee joint, an experimental approach to its roentgen pathology is presented.

2. More than 190 defects of varying size and location have been produced in all

bones forming the knee joint. They involve cortex and spongy layer separately and combined. Comparison with the roentgenograms of the untreated control and with the films showing the defects filled with opaque material affords an opportunity to recognize the faintest signs of destruction and to mark out the limitations of roentgenologic procedure.

3. Our results show that not all osseous defects are visible on the roentgenogram in either frontal or profile view, but that they require a certain size in order to appear on the x-ray film. The minimum dimension necessary for visibility varies with the location of the defect. Conoid-shaped excavations involving only the spongy structure require a diameter of from 0.5 to 1.75 cm. at their base and a depth of from 0.5 to 1.9 cm. Disk-like cortical defects must have a diameter of from 0.5 to 2 cm. in order to be seen. The paper lists examples of locations especially favorable or unfavorable for visibility of destructive foci and points out the importance of different projections for their demonstrability.

4. Factors determining visibility of a defect are: (a) direction of its longest axis in relation to the central x-ray beam; (b) diameter of transradiated bone which is superimposed over the defect; (c) relative amounts of cortical and spongy matter in the overlying bone; (d) distance of the defect from tube and film; (e) character of border of excavation; (f) content of defect; (g) state of calcification of the surrounding bone.

5. In the light of the results of our experiments and based on clinical experiences, the limitations of the roentgen diagnosis in three affections frequently involving the knee joint are pointed out.

6. In this connection the following x-ray signs of tuberculosis of the knee joint are evaluated: (a) changes in the soft tissues; (b) alteration in the width of the joint space; (c) bone atrophy; (d) bone destruction; (e) sequestration. Special attention is called to the fact that a negative roentgenogram does not exclude the

possibility of tuberculosis of the joint, that the roentgenogram gives us a true picture of the stage, progress and prognosis of the disease only under certain reservations and that none of the classical radiographic signs of tuberculosis in themselves are typical for this affection. One or more of these signs may frequently also be found in non-tuberculous lesions.

7. In regard to the roentgen diagnosis of osteogenic sarcoma of the knee joint it is pointed out that this affection may be present with negative roentgen findings; that the roentgenograph does not give us an absolutely true picture of the extent, character, and progress of the lesion, and that no roentgen sign of osteogenic sarcoma is absolutely characteristic for this affection. The example of a compact island which is well defined on a film of a thin section but barely visible on the roentgenogram of the complete femur, enables us to recognize the limitations of the x-ray method in demonstrating productive processes.

8. The first stage of osteochondritis dissecans will escape roentgen diagnosis. Model experiments imitating later phases of the disease showed that visibility depends mainly on the width and position of the radiotranslucent ring around the necrotic bone fragment. When the line of demarcation did not exceed one millimeter the front view was always negative and the side view gave only a faint and interrupted outline of parts of the fissure surrounding the fragment. Clinical experience teaches us that even in this disease, whose roentgenogram seems so typical, there are no absolutely pathognomonic x-ray signs. Other affections may in rare cases simulate its x-ray signs.

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# REMARKS ON CHAUL TUBE THERAPY<sup>1</sup>

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THE Department of Radiation Therapy at the General Hospital, Birmingham, has now completed two years' work with the x-ray tube associated with the name of Professor Chaoul, of Berlin (1). This period is, of course, too short for the presentation of figures on which you will be able to assess the permanent value and scope of any addition to the methods of treating malignant disease; nevertheless, some facts have been observed which already seem to be of value, and which I hope will serve to stimulate further research in this development of radiation therapy. The tube itself and the principles underlying its application have now been dealt with in considerable detail by various authorities. In British literature, Woodburn Morison and Mayneord (2) first drew attention to the method, which was discussed further and in considerable detail by Chaoul, Woodburn Morison, and myself at a meeting of the Radiological Section of the Royal Society of Medicine of London (3), in 1936. On the purely physical side, mention must be made of Mayneord's (4) invaluable paper, which should be read in detail by all those interested in this branch of radiation therapy, since a proper application of the physical factors is particularly important. Mayneord points out that the main feature of the complete distributions of the depth dose contours is the rapid drop in depth dose, as the rays enter the phantom. Using a 5 cm. target-skin distance and a circular port 5 cm. in diameter (total filtration equal to 0.2 mm. of nickel<sup>2</sup> and 60 kv.), the intensity measured at 2 cm. depth in

the usual phantom of water is only 40 per cent of that incident on the surface, at the center of the beam. For larger fields, greater than, say, 4 cm. in diameter, the peripheral drop also makes it imperative that one use a multiple field technic, but fortunately we have a considerable knowledge of the distribution of radiation around complex radiation sources, developed from radiation treatments (5), and this may be applied to the x-ray problem. He also estimates that the "average wave length" of the beam appears to be approximately 0.3 Å. The half value layer in copper is approximately 0.1 mm., and therefore too small to be determined very accurately. In aluminium, as indicated by the absorption curve, the half value layer is 3.3 mm., which would correspond with a homogeneous radiation of wave length 0.31 Å. I have suggested in previous papers that, though some radiologists might at first compare this quality unfavorably with that of x-rays produced at higher voltages, yet the comparison as regards effective wave length may not under all conditions be a fair one, since at depths of the order at which "deep" treatments are carried out, the effective wave length of a beam produced at (say) 200 kv., through a Thoriaeus filter, becomes very much the same as that from a Chaoul tube at the surface. This point is of interest if we assume that shorter wave lengths have in themselves some special value in their action on malignant cells.

Actual details of technic must be dismissed very briefly indeed. We have nearly always used the split dose technic, giving about 400 roentgens per session, up to minimum total doses of 6,000 roentgens for malignant lesions. Occasionally for small basal-cell carcinomas, a

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

<sup>2</sup> For practical purposes the filtration value of nickel is equal to an equivalent thickness of copper.

single dose of 2,000 roentgens has been given with complete success, in the case of patients who lived at a distance and could not attend. On the mucous membranes the reaction which Coutard has called "epithelitis" is attained and heals in about eight weeks.

In a recent paper to the British Association of Radiologists, I stated that in my opinion the term "contact therapy" might be considered preferable to more accurate descriptions, since it conveys vividly the first principle of this form of treatment—that it is suitable only for lesions which can be brought into direct contact with the applicator, either by reason of their situation on a surface or because they have been made accessible by surgery. In cases in which the target-surface distance is so short, accurate positioning of the applicator is absolutely essential, if even dosage is to be attained. I have also indicated four cardinal principles (6) for the satisfactory treatment of malignant disease by radiation, which must be applied and appreciated.

1. Any proposed form of treatment must include elimination of any source of chronic irritation.
2. Special attention to the growing edge of the tumor is essential.
3. Any form of treatment must be adequate. A valuable paper by Halberstaedter and Simons (7) brings out this point very well, and incidentally illustrates how woefully often it is not fulfilled.
4. Some method of dealing adequately with the appropriate lymphatic glands must be included, for treatment to be considered really radical.

These four cardinal points should govern the choice and application of any method of treatment of malignant disease. For the Chaoul tube to fulfill Conditions 2 and 3 it will very frequently be necessary to use multiple ports of entry, arranged around the periphery of the tumor, and directed inwards. For Condition 4, I do not in general consider it capable, under

clinical conditions, of building up a sufficiently large total dose in the deeper glandular areas. The rapid diminution in intensity of the beam, both in the depths and at the periphery, to which reference has already been made, might at first sight appear to be a serious limitation, but actually it may be an advantage in dealing with certain types of tumors, both malignant and simple. For example, during the last two years, two patients suffering from large fungating epitheliomas on the dorsum of the hand have been successfully treated by the Chaoul tube, with complete healing and minimum disturbance of the extensor tendons. One of these cases may be quoted here in detail to illustrate this point.

E. G., female, married, aged 75 years, was seen on Dec. 9, 1935, complaining of an ulcer on the back of her right hand of four years' duration. Her family had insisted on her coming to the hospital because of the odor from the tumor. A fungating ulcer one and three-quarters by one and one-half inches, on the dorsum of the right hand, was fixed, tender, and very septic, with hard everted edges. No biopsy was made, but clinically the diagnosis of epithelioma could not be in doubt. No grossly enlarged epitrochlear or axillary glands were noted—a not uncommon point in elderly patients suffering from fungating malignant tumors. Chaoul treatment was begun immediately by two circular fields, each 5 cm. in diameter, centered over the upper and lower poles of the growing edge. The target-skin distance was 5 cm., and the other factors were 4 ma. at 60 kv., with a total filtration value of 0.2 mm. copper and an intensity of 80 r per minute. Each field received a total skin dose of 6,000 r, divided over 25 days. A fairly severe reaction followed, somewhat complicated by sepsis, which was treated by an emulsion of acriflavin in liquid paraffin, according to the following prescription:

"Acriflavin"	0.1
Aquae	20.0
Cerae Alb.	4.0
Paraffin Liquid ad	100.0

This patient was seen a month before the date of this report, when the condition was completely healed, and there were no palpably enlarged glands.

The use of multiple small fields concentrated on the growing edge is, on the whole, to be preferred to the use of a single field with the central ray directed through the center of the growth, except in the case of very small tumors such as warts or very early rodent ulcers. If a single field of a larger diameter than 3 cm. is used, my experience is that an adequate dose to the growing edge is possible only at the cost of giving a frank overdose to the center, with a resultant local necrosis, which is tedious in healing and may be quite painful. Adams, in Professor Morison's Clinic at the Cancer Hospital, London, has overcome this difficulty by providing an extra filtration, thicker at the center, and very thin at the edge so as to permit a beam whose maximum intensity is situated at the periphery. On the other hand, it is astonishing what a large total dose can be built up by the use of carefully planned multiple fields, particularly in dealing with exuberant or rather convex tumors, which are not situated too deeply.

The application of the Chaoul tube to lesions which have already received inadequate or unsuccessful radiation treatment is a question which cannot long be avoided, and is indeed to be expected in the practice of any new development in radiation therapy. Chaoul himself has repeatedly stated that lesions which have previously received irradiation by radium or high voltage x-ray are not suitable for treatment by his technic. In general, we have followed this advice, but we make the reservation that every case must be treated on its individual merits, and that the radiation therapist must maintain a certain mobility of attack, ready to adapt his methods in a moment to meet particular circumstances. When after every alternative has been considered, it has been decided to irradiate by means of the Chaoul tube a lesion which has already received unsuccessful treatment, I advise, firstly, a

careful survey of the situation, including exact details of treatment and dosage hitherto employed, followed in appropriate cases by the bold administration of a definitely determined dose of at least 6,000 r to the deepest part of the tumor. Anything less is inadequate. I cannot condemn too strongly the exhibition of small "sniping" doses, in the spirit of hopeful expectation that the new form of therapy may in some way prove more specific against malignant cells than one which has included some different wave length or technic, quite regardless of any properly planned total amount of radiation delivered to the tumor. I believe with Ralston Paterson (8) that "the lethal dose for true squamous epithelioma will ultimately be proved to be, for any one fixed over-all time, a remarkably constant figure regardless of where that tumor is situated, and that it probably ranges from 5,000 r in a week to 6,000 or 7,000 r in one or two months, while at the upper end of the scale we find the adenocarcinomas, still very doubtfully curable by external radiation alone, and regarding which we really have the haziest ideas as to the lethal dose." As indicated above, such a total dosage to a previously irradiated area can be given only in special circumstances, and a certain degree of acute necrosis is inevitable and to be expected. Here again the rapid diminution of intensity of the beam, due to the inverse square law and to the low voltage, makes its strict localization quite easy, not only at the sides of the irradiated area, but also in the deeper structures, and this is a most important point in the recovery of the necrosis. Time does not permit a detailed survey of all the criteria by which one would decide on this rather drastic form of treatment. My own feeling is that a consultation with a surgical colleague is often valuable, since some of these cases are undoubtedly best treated by surgery, particularly by diathermy, as advocated by Finzi (9). The great advantage of the Chaoul beam is the possibility of localization mentioned above,

by which any area of actual "overdose" or necrosis can be limited very sharply, so that healing follows in a reasonable length of time. A case history follows.

B. W., female, married, aged 40, was seen in September, 1935, with the following history. A small sore on the left cheek had been present for many years. In 1920 it was treated by "surface radium" (no details available), which failed to cure it, and it continued to "scab over" and occasionally to break down, until the middle of 1934, when it began to grow larger. In January, 1935, the ulcer was one and one-half inches in diameter, and was diagnosed clinically and microscopically as epithelioma supervening on a patch of lupus. It was treated by interstitial radium, and from details available I estimate that a dose of approximately 6,000 roentgens was delivered to the center of the tumor, through 0.5 mm. platinum screening. In spite of this treatment the ulcer did not heal, and though it diminished in area, it continued to penetrate more deeply, and became foully septic. The patient was sent to the X-ray Department in September, 1935, where, after careful consideration, it was decided to attempt Chaoul treatment, as a last alternative to an extensive and rather mutilating operation. A dose of 6,000 roentgens calculated to the floor of the ulcer was given in 15 sessions over 18 days, and then after a short rest of 10 days, a further 1,200 roentgens were given in three sessions—total dose of 7,200 roentgens in 18 sessions over 31 days. The result was a rather severe reaction, which was controlled by daily dressings with acriflavin emulsion. As a result of this heroic treatment, the deeply penetrating ulceration was arrested, and the condition healed steadily, though it was of course necessary to continue daily dressings for many months.

I have quoted an extreme case, but it does illustrate my point that even when, for various reasons, the effect of the Chaoul beam has been to cause necrosis of tissue, the effect is very strictly localized, and the

recuperative powers of the immediately adjacent tissues are unaffected. In less serious cases I have sometimes found it advisable and justifiable to allow several weeks to elapse before beginning Chaoul treatment, while the area to be irradiated is carefully cleaned and dressed daily with the flavin or eusol and paraffin. Another case follows.

J. P., male, aged 63, was seen on Oct. 23, 1935, complaining of an ulcer on the back of his neck. It had been treated elsewhere by intermittent doses of x-rays for two years (no definite dosage available). Although no biopsy was taken, the condition was quite obviously an active epithelioma, with typical hard everted edges, and a sloughing base. The patient was kept under careful observation for eight weeks, while he attended for dressings, and treatment by the Chaoul tube was postponed until January, 1936. Two circular fields of 3 cm. diameter, with a 5 cm. target-skin distance were used, and each field was given 4,400 roentgens in 12 sessions over 17 days. The heaped-up edges of the ulcer flattened out rapidly, and became perfectly healthy, but the central part remained as a shallow crater, which took many weeks to heal by granulation, and which was at first very tender and rather painful. To-day the neck looks perfectly healthy, there is a slight feeling of induration on palpation, but no suspicion of delayed necrosis. I cannot help thinking that had a more penetrating radiation been used a much more serious reaction might have been produced.

Another advantage of the strict localization of the Chaoul beam has been found in the treatment of the nodular skin recurrences sometimes seen following radical amputation of the breast for carcinoma. I think most of us now feel that this is a very grave condition, and that frequently, if not almost invariably, it announces the presence of metastasis elsewhere in the body, even though this may not be clinically apparent at the immediate time. In addition to this, we have to consider that any tissue which has suffered an extensive surgical operation is never an ideal



medium for the reception of a heavy dose of irradiation over a wide area. Whatever is the general consensus of opinion on these two points, I think that most radiotherapists will agree that a number of cases of skin recurrences following radical amputation are seen every year, the treatment of which by what may be called radical radiotherapy would be of no value in prolonging the life of the patient, and indeed would only cause her unnecessary distress. Such "skin nodules" are controlled with satisfactory ease and certainty by multiple small Chaoul fields, leaving the patient's general condition unimpaired by x-ray dosage including large volumes of tissue, and more able to tolerate heavy doses to visceral or skeletal deposits. Nodules in difficult situations, such as high up toward the axilla or in the anterior axillary wall, can readily be treated by the Chaoul tube. It is surprising how long many of these patients can survive in comfort if a group of skin nodules can be controlled, or a patch of external irradiation healed. A case history in point follows.

A. F., female, married, aged 56, was seen on Nov. 4, 1935, complaining of a fungating ulcer in the middle of an old radical amputation scar in the left chest wall. The amputation had been performed ten years previously, and had never quite healed. Four months previous to the present examination this small unhealed area became sore and began to weep and later to be odorous and to discharge. On examination, the mid-point of the old radical amputation scar in the left chest wall was found to be the site of a carcinomatous ulcer 6 cm. in all diameters, fixed to the lower anterior left ribs and to the left border of the sternum. An enlarged gland was noted in the right axilla (the left had been cleared at operation). Treatment by the Chaoul beam was begun on Nov. 5, 1935. The ulcerated area was divided into five fields: four (peripheral), 5 cm. in diameter; one (central), 3 cm. in diameter. Each peripheral field received 4,800 roentgens over 16 days, in divided doses of 400 roentgens,

and the central field 3,000 roentgens over 10 days, with a target-skin distance of 5 cm. The vitality of the tissues involved in the scar was, as one might have expected, not very good, and a severe reaction followed the above dosage. In the light of further experience I now consider that the central field was unnecessary. However, by the end of June (five months later) the whole area had healed, and no clinical evidence of malignancy could be detected. The enlarged gland in the right axilla had by this time become larger, but this disappeared after full doses of high voltage (200 kv.) x-ray filtered through 1.65 mm. copper, by three fields. In November, 1936, a small nodule appeared in the scar region just below the area treated by the Chaoul tube, and this was successfully treated by a further 4,000 roentgens, using a field of very small diameter (1.5 cm., with a target-skin distance of 5 cm.). This patient is still alive and clinically quite well. She has gained weight, and lives a perfectly normal life as a housewife.

Time permits my mentioning only one other point, but it is an important one—the question of co-operation with the surgeon in the treatment of inaccessible tumors, by the Chaoul tube. It is largely with this in mind that I suggested above that the term "contact therapy," although not strictly correct, has a certain value, as it does convey to the surgeon the idea that wide and ready access to deep tumors is desirable, and that the actual applicator at any rate must be brought into contact with the tumor on at least one of its surfaces. For example, in tumors of the tonsil, palate, or alveolus, removal of the teeth is frequently helpful in providing access for an applicator even as large as 5 cm. diameter, and indeed I have stated that, in general, the retention of the teeth in the treatment of malignant disease in the mouth by the Chaoul tube will be possible only in exceptional or very early cases. Again, it will be remembered that our President, in the nineteenth Silvanus Thompson Memorial Lecture, before the

British Institute of Radiology in London last year, referred to the intrathoracic application of x-rays to the stump of a tumor deeply situated in the chest, which might not be completely removable by the surgeon.

Access to rectal tumors may be provided by the Bardenhauer modification of Kraske's approach, involving removal of the sacrum, or by the perineal operation, in which the coccyx is removed. I have mentioned in previous communications a patient who was treated in this way in December, 1935, and since she is still alive and apparently well, I should like to quote her case in some detail, as illustrating, first, the possibilities which the Chaoul tube affords of being worked in a confined and rather difficult space, and, secondly, of how it may be combined with deep x-radiation.

A. E., female, married, aged 56, consulted one of the Honorary Surgeons of the General Hospital in November, 1935, complaining of increasing constipation and diarrhea, and of occasional rectal bleeding and discharge of mucus. Six months previously a very early carcinoma of the rectum had been removed by a local operation, and the continuity of the bowel restored, thus dispensing with the need for a colostomy. On rectal examination, the finger encountered an annular stricture, apparently fibrous, one and one-half inches inside the rectum, beyond which was a soft friable mass, extending chiefly on to the left side. Left iliac colostomy was performed on Nov. 11, 1935, and ten days later the rectum was excised by the perineal route, though with great difficulty. On the left side and rather posteriorly it was impossible to remove the growth completely, and the delivery of the rectum involved cutting through some actual malignant tissue at one point, leaving a considerable residue. The wound was only partially closed, and treatment with the Chaoul tube was begun on Dec. 8, 1935. At each session it was possible to introduce into the wound an applicator giving a target-surface distance of 5 cm.,

and a circular field of irradiation 5 cm. in diameter. This applicator was passed upward beneath the sacrum and applied to the area of residual growth. A dose of 6,000 r was given in 15 sessions over 17 days, at the end of which time the wound was beginning to close so that the daily introduction of the applicator was becoming rather difficult. A further dose of 1,000 roentgens to the tumor was then delivered externally over five days, by means of a high voltage set (200 kv., filtered through 1.65 mm. copper). This, of course, was easily done, as the skin overlying the tumor was, until that date, quite unaffected by radiation. The tumor area, therefore, received a total dose of 7,000 roentgens, over three weeks. The patient is still alive and in good health, and clinically appears well. A small sinus in the operation area is still discharging but does not cause serious inconvenience. Her gain in weight has been maintained.

I think from the above remarks there can be little doubt that, with the co-operation of the surgeon and increasing boldness of dosage, an increasing sphere of usefulness will be found for the Chaoul tube. I have attempted here to draw attention to some of its less obvious applications—clearly there remain many upon which I have not had time to touch. For example, the basal-cell carcinomas which so often occur in awkward situations, such as the ala of the nose and the canthus of the eye, or epithelioma of the vulva, notoriously difficult to treat by radiation because of the extreme sensitivity of the adjacent skin, can often be treated with advantage by the Chaoul beam.

In conclusion, I should indeed be ungrateful if I neglected to acknowledge the great kindness and help afforded me in Professor Chaoul's clinic at Berlin, and in Professor Woodburn Morison's Department at the Cancer Hospital, London. I should also like to thank the Honorary Radiologists at the General Hospital, Birmingham, for their help and advice, and

Lord Austin of Longbridge, for his generosity in making this research possible.

#### SUMMARY

1. The Chaoul tube gives a high surface intensity with a comparatively poor depth dose which must be taken into account when planning treatment. In certain situations this may be an advantage.

2. When comparing the effective wave length of the Chaoul beam with that of x-rays produced at higher voltages, allowances must be made for changes in effective wave length of the latter at a depth, due to absorption and scattering (including Compton effect).

3. Application of the Chaoul beam to areas previously irradiated by other meth-

ods must be undertaken only after due consideration and preferably after consultation with a surgeon.

4. Every attempt must be made to secure the co-operation of the surgeon in providing access to deep tumors.

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## A NEW DEVICE FOR RADIUM APPLICATION IN ESOPHAGEAL MALIGNANCY<sup>1</sup>

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WE have always felt that carcinoma of the esophagus should lend itself to more successful treatment than has been the experience of therapists. This belief is based upon the histologic picture, the absence of early metastases and of extension, and the method of approach in treatment. Squamous-cell epitheliomas, which constitute the most frequent histologic type, have proven relatively amenable to radium in other anatomic sites, and should show equally good results in the esophagus. Carcinoma in the esophagus only rarely yields distant foci of metastases, and usually extends locally, or within reasonable distance of the primary radium beam. The lumen of the esophagus may be considered a readily approachable anatomical site, especially since its passageway has been employed for many years as an entrance to the stomach with numerous appliances. Therefore, a moderately sensitive tumor that remains localized in an approachable site should offer some hopeful aspects in malignancy therapeutics. With these thoughts in mind, we have thrust aside the disparaging reports of the past and tried again, employing a new applicator.

Fundamentally, two basic means of approach to the esophagus have been utilized, the one through the esophagoscope, the second with the aid of gastrostomy. Any device that can obviate the use of either or both methods would indeed be accepted as superior. An operative procedure in older patients who are often weakened and emaciated, presents, in most clinics, a very high operative mortality. Although the use of the esophagoscope offers a ready means for direct examination, biopsy, and insertion of radium,

the discomfort and apprehension produced thereby never present any appeal to the patient.

To be sure, radium has been applied locally to esophageal lesions almost from the time of discovery of the new element. Numerous applicators have been devised for tube or seed implantation, and the best proof of their inefficacy has been the refusal of therapists to adopt them.

In 1904 Einhorn (5) presented an interesting device which was constructed from hard rubber and enclosed one radium tube. The short sound was held attached by a silk thread, and application was accomplished by the patient swallowing the thread. Forbes (7) in 1920, Beck (1) in 1921, Pinch (14) in 1922, Mills and Kimbrough (12) in 1920, and Morsh (13) in 1929, respectively, reported the use of various radium containers which were inserted through the esophagoscope.

Case (4) in 1923, Lewis (11) in 1924, Hanford (8) in 1922, and Watson (18) in 1936 advocate, in their respective reports, a preliminary gastrostomy before radium insertion. Modifications consist in swallowing a thread to be used as an anchor line, or subsequent use of the esophagoscope orally or through the gastrostomy opening.

In 1932 Teperson (16) presented a new device for use through an esophagoscope whereby the tumor mass may be well localized and radon seeds implanted directly in the tumor.

Of special interest in this review is the sound constructed by Jentzer (10), in 1922, which embodied some principles which we employ in our device. Essentially, it consisted of the radium cup hooked on to a mandrel, attached to a string, and a probe to yield rigidity to the applicator. After insertion, the probe and mandrel are unhooked, and the capsule, attached to the

<sup>1</sup> Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13-17, 1937.

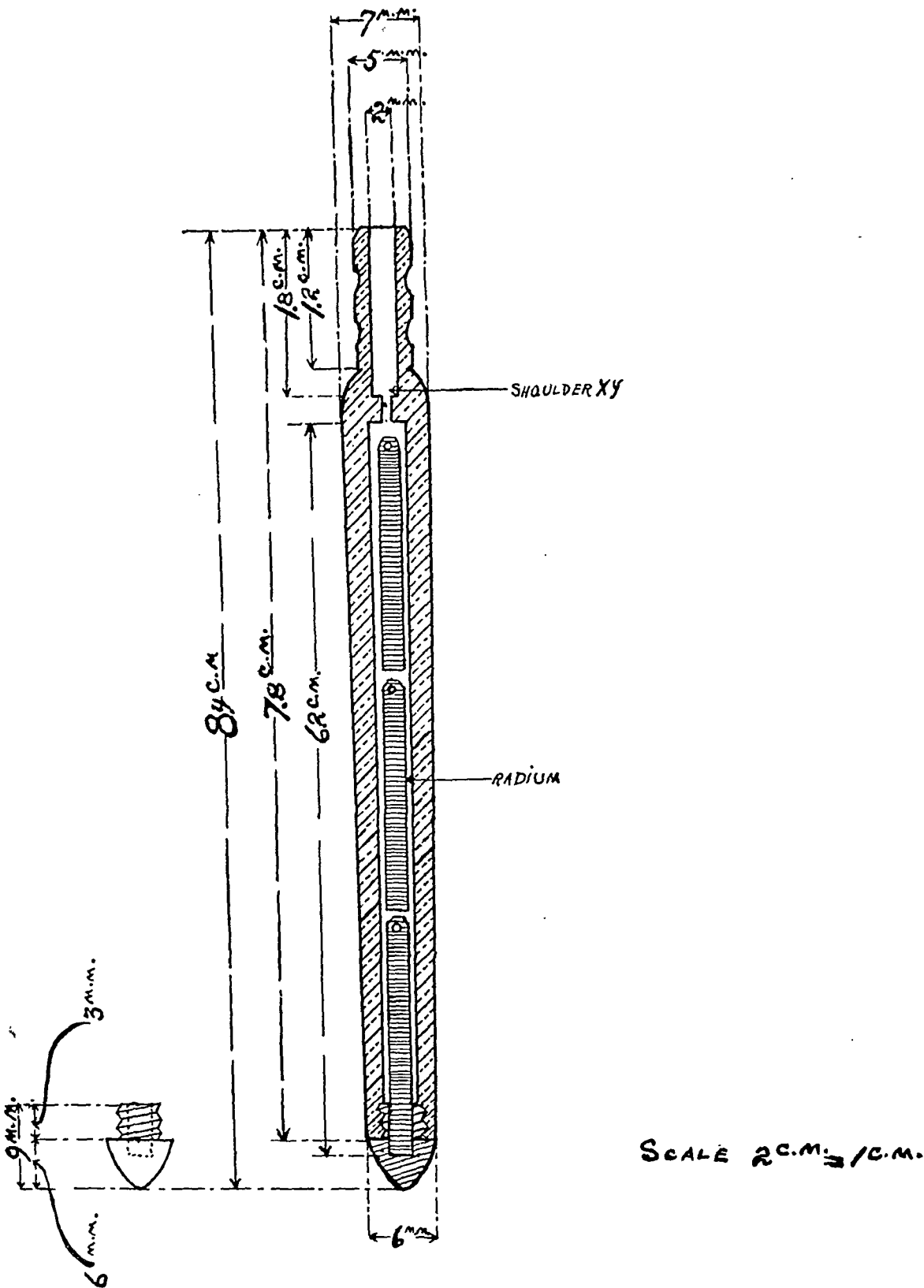


Fig. 1. Mechanical drawing of the three-tube radium capsule. XY is the shoulder through which the fishing cord passes and is held intact by means of a knot tied on the inner end.

string, is allowed to remain in place for the required time. Our observations in connection with the Jentzer applicator are

The capsule, made of hard rubber, measures 8.4 cm. over all with a hollow body 6.2 cm. long, a hollow neck, which is

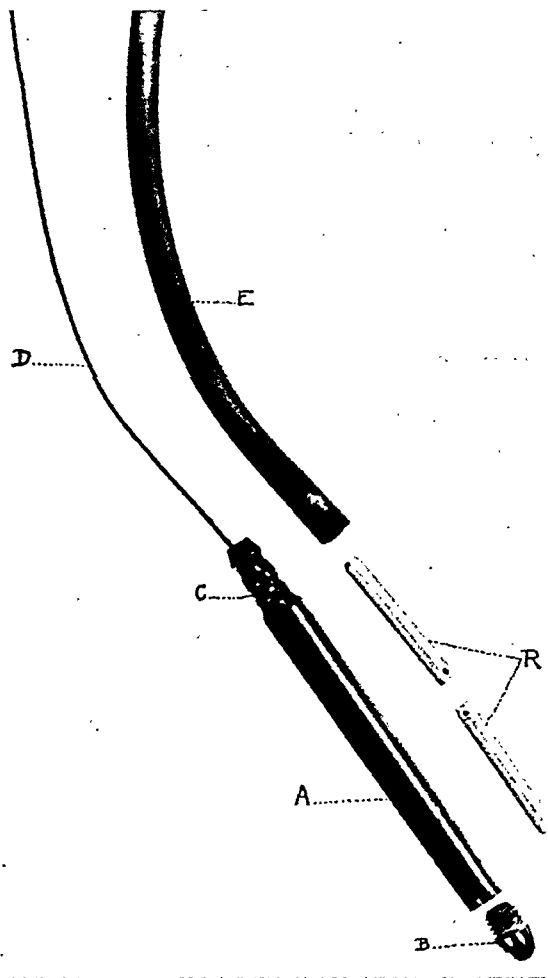


Fig. 2.

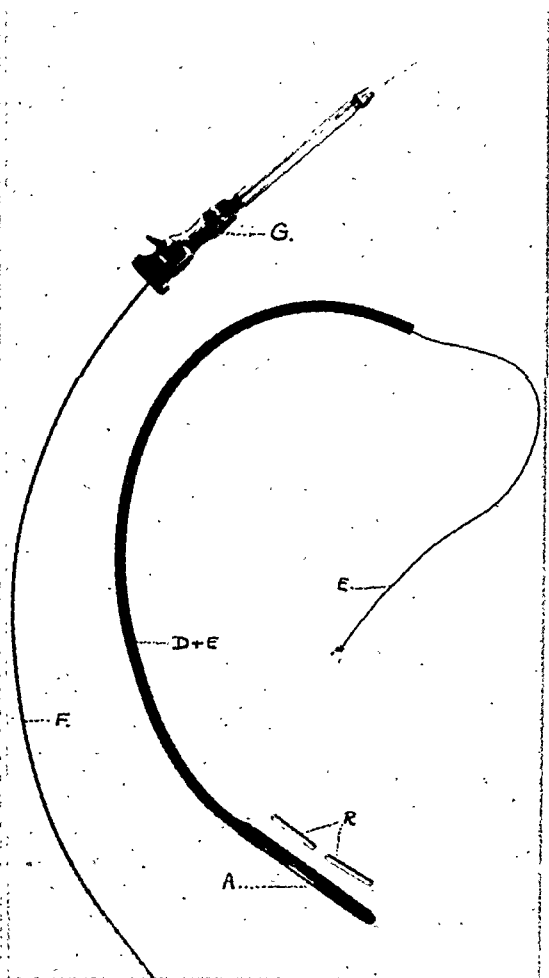


Fig. 3.

Fig. 2. Component parts of the esophageal applicator. *A* is the hard rubber capsule of 6.2 cm. linear measurement, *B* is the blunt screw tip, made hollow to accommodate part of a radium tube, *D* is the fishing line anchoring cord attached to a shoulder in the corrugated neck, *E* is the rubber tubing attached to the outside of the corrugated neck, *R*, radium tubes.

Fig. 3. The assembled sound with wire stylet. *F* is the flexible wire stylet, to which is attached *G*, the handle.

made not so much with a view of criticizing as from the standpoint of drawing attention to some of the salient features of our own device. It is difficult to imagine how the mandrel can force the cup down the esophagus when its contact with the cup is by means of a hook which may cause buckling.

*Description of Applicator.*—Our applicator consists of four parts: (1) capsule; (2) soft rubber tubing; (3) anchoring cord; (4) stylet and handle. (Fig. 2.)

corrugated on the outside, and a screw tip. A shorter capsule capable of holding but two radium tubes measures 6.2 cm. The capsule gradually tapers from an outside diameter of 7 mm. at its widest point to 3 mm. at the end of the blunt nose tip. The diameter of the hollow space is 5 mm. throughout, and the wall thickness is 1 mm. at the thickest point (Figs. 1 and 2).

At the proximal pole of the capsule is a shoulder separating the hollow of the corrugated neck from the hollow body of the

capsule (Fig. 1 -XY). This shoulder provides a passageway for the anchoring cord and is the contact point against which the distal end of the stylet lodges. The screw tip is hollow, allowing for part of one radium tube to be contained therein, thereby reducing the over-all length of the capsule.

The rubber tubing is made of latex rubber which gives it elasticity coupled with tensile strength, and, in addition, it imparts to it the quality of becoming smooth and slippery when emersed in water. The tubing—about 35 cm. in length—fits snugly over the corrugated neck of the capsule. This special construction of corrugation affords a very tight hold of the tubing onto the capsule.

The anchoring cord is a thin, linen fishing line (tensile strength of 27 pounds) which is attached to the capsule by means of a knot at one end, then passing through the shoulder from the hollow body to the hollow neck. It continues through the rubber tube and its free end is available for anchorage about the ear.

The stylet has two special features worthy of notice; firstly, the nature of the material, and secondly, the method by which the stylet is shaped. We have chosen No. 27 gauge piano steel wire because it combines flexibility with rigidity, it can be shaped with the hands, straightened out to its original position again, and hold the shape thus given it. This quality is increased by shaping the stylet into a square-shanked proximal end, and a tapered distal end. The square shank affords good contact for the jaw of the handle.

The handle is in the nature of a pin vise, with the square-shanked end of the stylet being firmly gripped in its jaws by a thumb screw. With this, easier and more delicate manipulation of the sound is obtained.

*Technic of Application.*—The diagnosis, to our minds, is satisfactorily established by roentgen-ray study alone. An irregular filling defect in a patient, often a male, of the cancer age with some symptoms of dysphagia, should warrant the diagnosis.

The upper and lower levels of the irregu-

larity as seen in the roentgenogram are indicated topographically, corresponding to the nearest bony structure, as the clavicle or anterior rib margin, and those are marked on the chest by means of ink or a skin pencil. This is done to indicate on the exterior the levels of the lesion for proper placement of the capsule.

Preparation of the patient includes abstinence from food for four hours previous to radium insertion, and morphine and atropine given in adequate doses. The nasopharynx is cocaineized to only a moderate extent, enough to lose the pharyngeal reflex, but not to include the larynx or upper trachea.

The instrument is prepared by placing two or three radium tubes into the hollow capsule, and screwing the blunt tip on tightly. The wire stylet is lubricated with jelly, thrust through the rubber tubing, and made to lodge upon the shoulder in the capsule (Fig. 4).

With the patient sitting upright and the head completely extended, the tongue is flattened with a depressor, and the capsule, slightly lubricated with jelly, introduced as far back as the posterior pharyngeal wall. Holding the rubber tubing and stylet about five inches from the terminal sound with one hand, the other hand is placed on the handle, with the anchoring cord wound around the fingers. It is essential to keep the cord taut, thereby assuring constant contact of the distal end of the stylet with the shoulder. Curve the stylet to an arc of about 60 degrees. In this fashion, the inserting tip and a length of six inches is actually a slight arc. The patient is then asked to swallow, and during the act of deglutition, the first gentle thrust is made and the esophagus entered. Pressure is brought to bear very gently, and the sound will proceed downward until the tumor mass is reached. Here, the sensation of the mass is easily transmitted to the fingers because there is a continuous flow of force from the tip of the sound through the stylet, through the handle, and to the fingers. Slow manipulation is made in all directions, maintaining almost a straight

line with the distal end of the sound, until the constricted lumen is found and passed. The moment the lesion is passed the sensa-

insertion to recheck the level of the sound in the lesion. Principally because the pharyngeal reflex has been depressed by

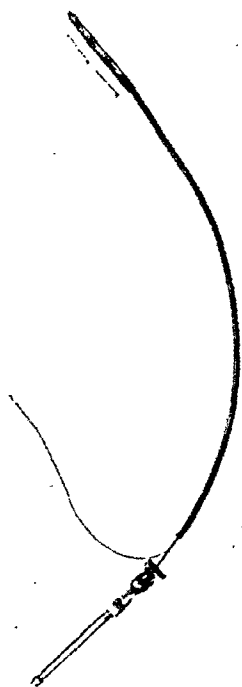


Fig. 4.

Fig. 4. The completely assembled applicator with two radium tubes on the side. After insertion, the handle and wire stylet are slowly withdrawn, leaving the capsule, anchoring cord, and rubber tubing in place.



Fig. 5.

Fig. 5. Several dilators of various sizes along with the regular capsules. The wire stylet is similarly employed here to exert gentle pressure into the lumen of the esophagus.

tion of all resistance disappears. It is essential to reach a level below the lesion. When one has felt that the sound is well inserted, the long wire stylet is slowly, and with slight rotary motion, withdrawn; the rubber tube and anchoring cord will remain in place.

The patient is then fluoroscoped. With the skin markings previously described upon the chest wall as a guide, the capsule, by means of the cord, is slowly drawn upward to the level. Another method is to measure on the x-ray film the level of the irregularity and to pull the sound up to that definite level while under the fluoroscope. The anchoring cord is wound about the ear, and adhesive employed to seal it securely.

Emphasis is placed upon the suggestion to refrain from giving barium soon after

cocaine, and any attempts at swallowing may allow some barium to enter the trachea, producing violent coughing spells—enough to dislodge the sound. If one desires a recheck, it may be done later when the cocaine effect has entirely disappeared.

During insertion great care and gentleness must be exercised. Forceful pressure should not be employed because, if it is indicated, the presumption is that the distal tip of the sound is up against a pocket of the tumor mass, and damage may ensue. Although perforation is always an imminent danger, we feel that the tip of the sound is constructed so bluntly, that perforation appears as a remote possibility. Moreover, by lateral manipulation, drawing upward, and gentle thrust, the lumen



should be found, and the rest of the passage accomplished without difficulty. Manipulation must be by gentle but firm movements. Until the wire stylet is withdrawn the patient may experience tension about the trachea and bronchi to produce some cough. This is suddenly relieved when the stylet is removed. The latter step should be performed slowly and with rotary movements.

If the insertion does not appear satisfactory, or if the probing stylet is once partially withdrawn, attempts at insertion should not be made without withdrawing the sound completely. This is important because of the mechanics of the applicator, for it is essential that the distal end of the stylet remain constantly on the shoulder of the capsule (Fig. 1), thereby assuring a continuous flow of force. If the stylet has been withdrawn from the neck, pressure may push the distal end through the thin rubber tubing against the walls of the esophagus. Indeed, that is a dangerous procedure.

Instances will be presented in which the radium-containing capsule will not pass the obstructed area with ease. Rather than forceful pressure, we have devised several small dilators made of the same hard rubber, but of slightly smaller diameter, and of lesser linear measurement. Manipulation with the smaller dilators is much easier. The irregularly constricted lumen can thus be slowly dilated until the

larger capsule will pass with relative facility (Fig. 5).

These small dilators are inserted with the same technic as previously outlined, and with the application of the same principles. We do not advocate the gradual dilatation of the lumen in every case, because frequently the prepared, loaded radium capsule will find simple passage. Only when the sound cannot be passed should the dilators be employed.

To date, the dose we have employed has been two or three tubes of radium, of 10 mgm. each, filtered through 1 mm. of platinum. The thickness of the sound is 1 mm. of hard rubber, enough to absorb all characteristic secondary rays. The sound is permitted to remain *in situ* for from 24 to 48 hours in the first application, to yield a dose of from 480 to 1,440 mgm.-hours. A second application is made within several days, and if the condition of the patient is good, insertions are repeated at three-day intervals until a dose of from 4,000 to 5,000 mgm.-hr. is given.

During the interval when the radium is in place, olive oil, one ounce three times daily, sodium bicarbonate, and sedatives are given. Liquids such as milk, egg-nogs, and whiskey are fed; and if the state of emaciation is pronounced, clysis and intravenous infusions are indicated. The degree of discomfort felt by the patient is, as a rule, negligible, and morphine is seldom necessary.

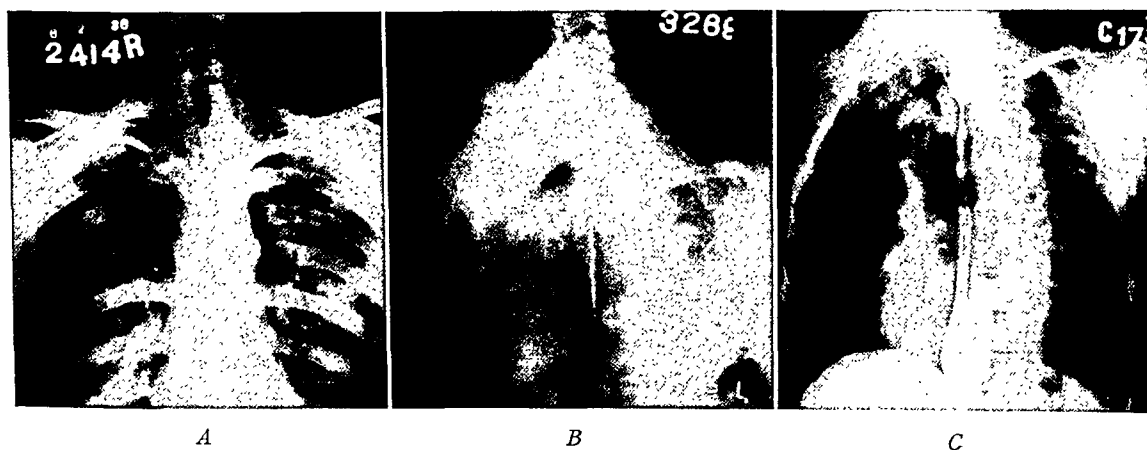


Fig. 6. Case I. A, carcinoma of upper third of the esophagus; B, radium capsule in place. C, one month later, irregularity is less, and dilation has disappeared.

## CASE REPORTS

Case I. S. E., male, 52 years of age, complained of dysphagia of four months' duration. Food did not go down. He had no pain, nausea, vomiting, or bleeding. Liquids descended easily. He had lost eight pounds in weight. A roentgenogram revealed an irregular filling defect at the junction of the upper and middle third of the esophagus. The radium capsule was inserted as follows: three 10-mgm. tubes for 48 hours; three weeks later, three 10-mgm. tubes for 48 hours; three weeks

later, two 10-mgm. tubes for 44 hours; six days later, two 10-mgm. tubes for 48 hours; eight days later, two 10-mgm. tubes for 48 hours. The total dose thereby administered was 5,600 mgm.-hours over a period of eight weeks. Shortly after the last radium insertion, the patient was able to swallow with greater ease, gained six pounds in weight, and felt well. Unfortunately, this patient who appeared to respond well was seized with the epidemic respiratory infection of last year, and died of a pneumonia following such an attack (Fig. 6).



Fig. 7. Case II. *A*, large, irregular lumen in upper third of the esophagus. *B*, radium in anatomical area corresponding to lesion. *C*, lumen smooth and even.

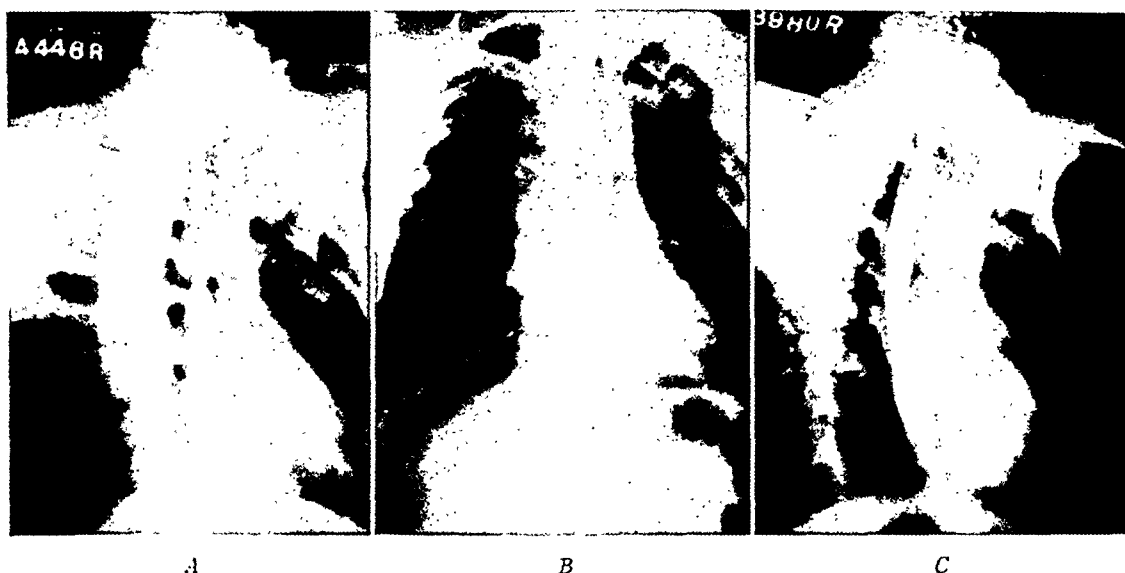


Fig. 8. Case III. *A*, carcinoma in lower third of the esophagus near the cardiac end. *B*, radium capsule in corresponding area. *C*, some widening of previously constricted lumen.

Case II. J. S., male, aged 60, complained of hoarseness and pain in the chest of six weeks' duration. A roentgenogram showed a filling defect at the junction of the upper and middle third (Fig. 8). A radium capsule with two 10-mgm. tubes was inserted and held in place for 17 hours. Five days later another application was given for 21 hours, and 15 days later, another for 65 hours, this time using the three-tube capsule. An esophagoscopy was then done, and a small tab of tissue removed disclosed histologic evidence of fibrosis with several scattered malignant epithelial cells. Three weeks later, another capsule with three 10-mgm. tubes was inserted for 40 hours. The total dose was, therefore, 3,900 mgm.-hours. Two months subsequent to the last treatment the patient suffered a sudden hemorrhage from the mouth and died within several minutes. At necropsy, the esophageal lesion was found scarred but there was extension above and into the left subclavian artery (Fig. 7).

Case III. W. V., male, aged 58, complained of dysphagia of six months' duration and a loss of 20 pounds during the same interval. An x-ray examination showed a linear filling defect in the lower third of the esophagus next to the cardia of the stomach.

A radium capsule with two 10-mgm. tubes was kept in place for 24 hours; three days later, the same capsule for 24 hours, and four days later, a three-tube capsule was inserted for 48 hours, the total dose of 2,500 mgm.-hours having been given. This patient with arteriosclerotic heart disease, soon developed ascites and jaundice. The course was rapidly downhill, without great improvement, and he died one month after the last radium insertion. At postmortem, the esophageal lesion was found with little response to the radium therapy and metastases to the liver and pancreas were present (Fig. 8).

#### CONCLUSIONS

We offer this esophageal applicator as a

simple and effective means of placing and keeping radium tubes in a carcinoma of the esophagus. The sound is simply constructed, easy of insertion, with slight discomfort, if any, either during application, or in the interval when it is in place. This method obviates esophagoscopy or gastrostomy. We feel that if insertions can be made simply, and repeated as often as indicated, and without any operative intervention, a new field in this form of tumor therapy may be opened. In any event, palliation is accomplished in the simplest manner.

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# PANCREATIC LITHIASIS, WITH A CASE REPORT AND AUTOPSY FINDINGS

By WILLIAM A. MARSHALL, M.D., *Chicago*

PANCREATIC lithiasis was first described by Graaf in 1667. It is a rare condition, only 147 cases having been reported in the literature so far. The case to be reported now will be the one hundred forty-eighth case.

*Etiology.*—The exact etiology is not known. Stasis of pancreatic secretion ap-

on account of a chronic inflammatory process in the ducts or due to some chemical alteration in the pancreatic secretion.

*Pathology.*—Pancreatic stones are mostly multiple, and are distributed throughout the pancreas. However, cases have been described with only a solitary stone which then is mostly in the head of the gland.

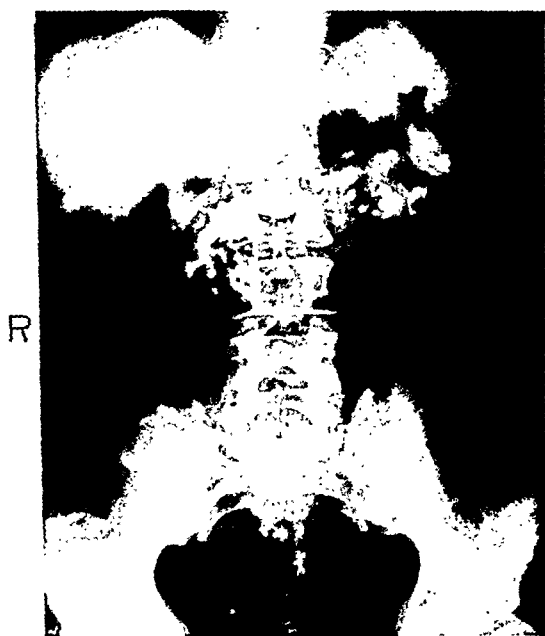


Fig. 1.

Fig. 1. Postero-anterior view of abdomen showing the pancreatic concretions following closely the anatomical location of the pancreas.

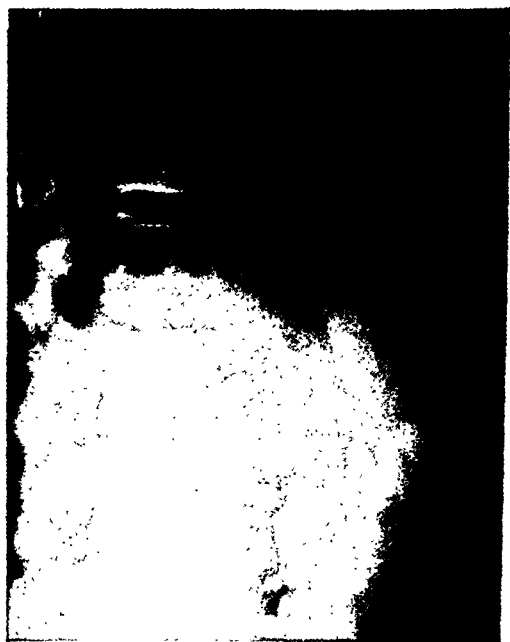


Fig. 2.

Fig. 2. Lateral view of the abdomen.

parently does not produce stones. Mann and Giordano have shown that ligation of both pancreatic ducts in animals does not produce stones. Also a back-flow of bile into the pancreatic ducts will not do it. Most of the stones that have been examined contained calcium carbonate and calcium phosphate. The normal pancreatic secretion does not contain either one. However, chronically inflamed tissues may produce calcium. The assumption, therefore, is that the stones are formed either

The stones are mostly the size of a cherry stone or slightly larger. Occasionally small gravel-like concretions are found. Sometimes the ducts are incrustated with sand. The largest stones were described by Shupman and Matoni. Shupman's stone measured 2.5 X 0.5 inches and weighed 200 grains. Matoni reports one stone weighing two ounces. The stones are white or grayish-white in appearance and irregular. Seldom are they faceted. They produce a chronic interlobular pan-

creatitis and in the late stages a fibrosis of the interstitial tissue. It is only in the late stages that, due to the fibrosis, the islands of Langerhans are destroyed. Therefore, diabetes does not occur until quite late in the disease.

*Symptoms.*—The most outstanding symptom is pain in the epigastric region. This pain may be either dull and more lasting in character, or colicky and very sharp but of shorter duration. It generally radiates into the back, very often into the left side. Sometimes the pain is agonizing in character, associated with vomiting, cold sweats, and collapse. Some attacks are similar to those due to gallstones. Minnich and Holzmann found fragments of stones in the stools after each attack. Lack of appetite and loss of weight are common. The weight loss is probably due to impairment of the digestion on account of lack of pancreatic secretion, following the atrophy and destruction of the glandular tissue. Jaundice has been found quite frequently, due to (1) stone obstruction of the papilla of Vater, (2) pressure on the bile ducts, or (3) co-existing biliary disease. Diarrhea was present quite often. Sometimes there were fatty stools. Most writers report that diabetes occurs either quite late in the course of the disease or not at all, because usually the islands of Langerhans are destroyed only when a secondary fibrosis or cirrhosis sets in. The specimen obtained through operation in our own case showed complete destruction of the pancreatic glandular tissue but the islands of Langerhans were well preserved.

Complications that may follow the presence of stones are abscess formation, cyst formation, carcinoma, duodenal ulcer, and appendicitis.

*Diagnosis.*—A correct diagnosis has seldom been made before operation. The most important means of arriving at a positive diagnosis is the flat roentgenogram. The stones usually contain calcium carbonate and calcium phosphate and they can readily be demonstrated on the x-ray plate. The differential diagnosis between pancreatic stones and calcified mesenteric

glands is sometimes difficult. Since the advent of the gall-bladder dye it should always be possible to exclude gallstones. During the routine gastro-intestinal examination the barium-filled stomach may lie

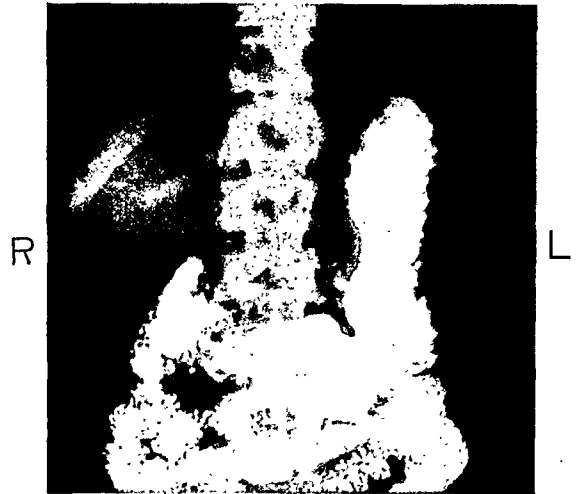


Fig. 3. Postero-anterior view of abdomen after barium meal, showing many of the concretions covered by the stomach. The presence of the stones may easily be overlooked during the routine gastro-intestinal examination.

just in front of the pancreas and pancreatic stones may be missed. If, therefore, in the presence of epigastric pain the usual gastro-intestinal examination is negative, it is advisable to keep the possibility of pancreatic stones in mind and to take a plain film after thorough evacuation of the barium. The correct and early diagnosis of stones in the pancreas is of great importance because in many cases surgery can bring complete relief, before an extensive destruction and atrophy of the glandular tissue has taken place.

*Treatment.*—The most efficient treatment is operative. Bost reviewed 28 cases that were operated on; the mortality was about 7 per cent. The post-operative results were very good. Fat necrosis or post-operative fistula did not follow the operation, which consisted mostly of removal of the stone and the drainage of abscess or cysts.

## SUMMARY

1. Pancreatic lithiasis is a rare disease. The most constant symptom is pain in the epigastric region radiating toward the back or toward the left side.



Fig. 4. Postero-anterior view of abdomen after the administration of a barium enema.

2. The presence of epigastric pain without demonstrable lesions in the stomach or in the gall bladder should arouse the suspicion of pancreatic lithiasis.

3. The most important means of arriving at a diagnosis is a plain x-ray view of the upper abdomen. The routine gastro-intestinal study with the use of barium may hide the stone.

4. Early diagnosis is of extreme importance as timely surgery may cure the patient by preventing atrophy and destruction of the glandular tissue. The most efficient way of treating pancreatic lithiasis is surgical removal of the stones.

## REPORT OF CASE

The patient, Mr. H. F., a German tool-maker, 48 years old, gave the following history: He had been quite well until three months before when he began to develop a

pain in the epigastric region and in the back, radiating toward the left lumbar region. This pain was of a dull character, would last about 20 minutes, and then disappear for about three or four hours. It would be relieved by taking aspirin. It had no relationship with meals. He had lost about 10 pounds in weight during the last three months. Physical examination showed a fairly well-nourished man who did not appear acutely ill, weighing 133 pounds. He was five feet six inches tall. Pulse rate, 88, blood pressure 144/96. On palpation of the abdomen there was a definite tenderness in the epigastric region and in the left upper quadrant. Below the left costal arch there was also some rigidity. On firm pressure some small nodules could be felt in this area. The urine analysis showed no albumin or sugar. There were 25 to 30 pus cells per high-power field and occasional blood cells. Some mucus was present. The blood examination showed 4,970,000 red blood corpuscles, 6,200 white blood corpuscles. Hemoglobin was 100 per cent. The differential count showed 62 per cent polymorphonuclear, 24 per cent small mononuclear, and 14 per cent large mononuclear. There was some anisocytosis and poikilocytosis. A gastro-intestinal x-ray examination was done. The postero-anterior view of the stomach after the administration of a barium meal showed a negative stomach and duodenal cap. Above the pyloric area several irregular-shaped shadows were seen that were first thought to be mesenteric calcified glands (Fig. 3). After thorough evacuation of the barium meal a flat plate was taken which showed numerous irregular calcareous shadows in the upper abdomen closely following the anatomical location of the pancreas (Fig. 1). The patient was admitted to the Alexian Brothers Hospital July 28, 1937. During the following few days there was no marked improvement. He had poor nights and complained of repeated attacks of sharp pain. On Aug. 4, an exploratory laparotomy was done (Dr. A. G. Zimmermann). Through a median incision above the umbilicus the

upper abdomen was explored, and above the transverse colon below the liver a hard nodular mass was discovered in the retroperitoneal space. The tumor was left in place but a portion was removed for biopsy. A drain was inserted and the abdomen was closed. The pathologic report as given by the pathologist, Dr. J. P. Simonds, reads: "Stone in pancreatic duct with complete atrophy of the parenchyma of the pancreas in the tissue removed, leaving only the islands of Langerhans." The patient had a stormy post-operative course. He developed a high temperature, was mostly very restless, coughed severely, and complained of severe pains through the chest. The ordinary medications did not relieve the cough. He became more and more dyspneic and died Aug. 16 (12 days after the operation) under pulmonary and cardiac symptoms.

*Autopsy Findings.*—The following anatomical diagnosis is an abstract of the autopsy findings as reported by Dr. J. P. Simonds:

1. Multiple concretions of the pancreatic duct.
2. Dilatation of the pancreatic duct.
3. Marked atrophy of the pancreas.
4. Carcinoma of the body of the pancreas.
5. Recent surgical removal of a portion of the atrophied pancreas.
6. Lobular pneumonia, bilateral.
7. Gangrene of the lungs, most marked in right lower lobe.
8. Edema of the lungs.
9. Acute fibrinopurulent pleurisy, right side.
10. Occlusion of splenic vein by tumor growth.
11. Passive hyperemia of the spleen.
12. Multiple recent infarcts of the spleen.
13. Metastatic carcinoma of the liver and lungs.
14. Parenchymatous degeneration of the liver and kidneys.
15. Localized acute gastritis and perigastritis.

16. Deficient yellow pigment in adrenal cortex.

17. Eustachian valve in right auricle.

18. Focal fibrous adhesion in left pleural cavity.

19. Gauze drain in upper abdominal cavity.

20. Recent laparotomy surgical incision.

21. Needle puncture wound in right antecubital space.

The pancreas is thickened and indurated, particularly in its middle portion. It measures 18 cm. in length and in the middle portion is 6.5 × 4.5 cm. in diameter. There is a mass of slightly hemorrhagic and discolored (brown) tissue at the junction of the middle third and the lateral portion, forming a lining for an irregular cavity. The latter contains several surgical sutures, and a thin coating of fibrinous exudate is present both in the cavity and on the anterior surface of the pancreas. The pancreatic duct is unevenly dilated, reaching a maximum diameter of 15 mm., and filled with closely packed concretions of various sizes and shapes. The largest single stone measures 2.5 cm. in length and up to 12 mm. in diameter. The surfaces of the stones are finely granular, and white to yellowish-white. Surfaces made by section through the indurated portion of the pancreas show pale yellowish-gray, moist tissue, which suggests an infiltration with tumor tissue rather than purely a fibrous induration. The pancreatic tissue of the medial and lateral thirds appears to have been completely replaced by fibrous and adipose tissue. The opening of the pancreatic duct at the ampulla of Vater admits a 1 mm. size probe.

I am indebted to Dr. Leopold Frey for referring this case to me, and to Dr. J. P. Simonds for furnishing the autopsy reports.  
100 W. North Ave.

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Only the most recent references are listed. An extensive review of the older literature dating back to the middle of the last century was compiled by Seeger (25).



## FOREIGN BODY LOCALIZATION IN MILITARY ROENTGENOLOGY<sup>1</sup>

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THE problem of localization of foreign bodies is one of the most important considerations of military roentgenology. Since 1919, almost coincident with the end of the military surgery of the World War, there has been very little progress or attention paid to this subject in the United States.

It is the purpose of this paper to give a brief tribute to the excellent work done in the correlation of radiographic foreign body localization by James T. Case (35), J. S. Shearer (123), David R. Bowen (16), and the collaborators on the U. S. Army X-ray Manual (137) in 1918; to report the important methods described since the publication of these works in recent years; to correlate terminology and classify the many methods described under the heading of principles involved, and to outline the present recommendations approved by the Office of the Surgeon General for use in case of a national emergency.

Mention of the methods found in our search of the English literature will be made, with references for those who wish to delve more deeply into the subject. That it is obviously impossible to describe every method ever published will appear at once to anyone attempting to cover this subject. No doubt many references will be available in addition to those which we mention; in fact, a direct attempt has been made to delete from this study any report which did not add to the knowledge of the subject. It has also become necessary, because of the length of the discussion, to omit the consideration of foreign bodies in the eye and food and air passages, considering them as a distinct and separate topic. It will also be seen that the many

interesting developments of so-called "slice radiography," such as the Laminograph, the Subtraction Method, special bi-plane fluoroscopy and other methods which require large amounts of special apparatus, are not subject for consideration here as they are still somewhat experimental and are impractical for the average small installation.

That this paper has a twofold mission must be recognized at once. First, it is an attempt to assemble and classify the knowledge of the subject under one heading for easy reference in the case of emergency, and second, it is an outline for the guidance of the Military Medical Service in the methods approved by the Surgeon General of the Army.

In carrying out our first objective we refer to Dr. Case's (35) and Dr. Bowen's (16) articles to bring the knowledge of the history of the various methods up to 1918. To attempt a summary or condensation of the material included in these papers would do them injustice and slight a very interesting portion of the knowledge of this subject.

In 1918 we find that Major J. S. Shearer published a paper (123) in which he described the "Standard Methods Approved by the Surgeon General's Office, U. S. Army, for Localization of Foreign Bodies." This paper undertakes a complete description of the following methods:

1. Two-wire, Double Tube Shift Method of Strohl.
2. Parallax Method of Blaine.
3. Tube Shift with Mechanical Triangulation.
4. Profondometer of Flint.
5. Hirtz Compass with accessory devices.
6. Sutton's Cannula and Trochar with Harpoon.

<sup>1</sup> Approved by the office of the Surgeon General, U. S. Army, Washington, D. C.

## 7. Fluoroscopic Guidance with intermittent control.

These methods are also explained in detail in the U. S. Army X-ray Manual, first edition (137), and an added insert is found in this volume describing the Nearest Point Method.

No further publication concerning this work, as far as the Army is concerned, is found until 1932, when Lt. Col. Pillsbury presented the Second Edition of the Manual (138). In this work the following methods are approved:

1. Two-wire, Double Tube Shift Method of Strohl.
2. Nearest Point Method.
3. Radiographs at right-angle planes (Two-plane Method).
4. Operative removal under the fluoroscope.

It is to be seen from this that the Parallax Method of Blaine, Tube Shift with Mechanical Triangulation, Profundometer of Flint, Hirtz Compass, and Sutton Cannula and Trochar methods were deleted from the teaching text of military roentgenology between the years of 1918 and 1933. The reason for this action was not necessarily because of any lack of value of these methods but because of the inherent difficulties of their successful application in the ordinary roentgenological installation.

The textbook of the Army Medical School, Department of Roentgenology, entitled "Roentgenographic Physics for Officers and Enlisted Technicians," by Lt. Col. W. W. McCaw (101), instructs in the following methods:

1. Two-wire, Double Tube Shift of Strohl.
2. Modification of Single Tube Shift and Mechanical Triangulation (very much as described by Trout, 135, 62).

This shows a return to the Single Tube Shift Triangulation Method but does not give detailed instruction in the Nearest Point Method, Two-plane Method, and

Fluoroscopic Guidance; the only method to survive all these studies is the Double Tube Shift, Two-wire Method of Strohl.

A survey of a number of the best standard textbooks published in the five-year period ending January, 1937, shows the following methods discussed:

1. *Outline of Radiology*, Educational Committee, Pennsylvania Radiological Society, 1937 (54).
  - (a) Strohl Two-wire, Double Tube Shift Method—described in detail.
  - (b) Parallax Method—merely statement of principle.
  - (c) Single Tube Shift with Mechanical Triangulation (apparently not so common as a).
  - (d) Profundometer—stated to be non-practical.
  - (e) Hirtz Compass with accessory devices—stated to be complicated and impractical.
  - (f) Cannula and Trochar with Harpoon—regarded as least desirable method.
  - (g) Profunda Method—described.
  - (h) Stereoscopic Method—merely mentioned.
2. *Textbook of Diagnostic Roentgenology*, Friedman, 1937 (59).
  - (a) Two-plane Method (right-angle films).
  - (b) Single Tube Shift with Triangulation—not described in detail.
3. *Textbook of Roentgenology*, Harrison, 1936 (77).
  - (a) Two-plane Method.
  - (b) Nearest Point Method.
  - (c) Stereoscopic Films.
  - (d) Single Tube Shift with Triangulation.
  - (e) Biplane Fluoroscopic Guidance—not described in detail.
4. *Roentgen Interpretation*, Holmes and Ruggles, 1936 (81).
  - (a) Biplane Fluoroscopy.
  - (b) Nearest Point Method.
  - (c) Modified Strohl Method.
  - (d) Fluoroscopic Control.

5. Roentgenographic Technic, Rhinehart, 1931-1936 (117).
  - (a) Fluoroscopic Control and Guidance.
  - (b) Two-plane Method.
  - (c) Single Tube Shift with Triangulation—in detail.
6. X-ray Studies III, General Electric Co., Trout (135, 62).
  - (a) Single Tube Shift with Triangulation.
7. Manual of Radiological Technic—Sante, 1935 (118).
  - (a) Fixed Angle Method of Strohl.
  - (b) Parallax—statement of principle.
  - (c) Profunda.
  - (d) Combined Profunda and Parallax.
  - (e) Barium Wash.
8. Jerman and Köhler make no mention of the subject.

#### CORRELATION OF TERMINOLOGY AND CLASSIFICATION OF METHODS BY PRINCIPLE INVOLVED

##### I. Fluoroscopy Principle.

- (a) Simple fluoroscopic localization; to include general survey methods (117, 137).
- (b) Removal of foreign bodies under simple fluoroscopic guidance (137, 117, 103, 16, 33, 31, 5, 123).
- (c) Biplane fluoroscopy; two tubes and two screens at 90 degrees to each other (77, 102).
- (d) Stereo-fluoroscopy; Caldwell, Imboden, Mackenzie Davidson. Alternately energized tubes with shutter arrangement applied to stereoscopic view system (29, 35, 104).
- (e) Bonnet fluoroscope; Eastman and Bettman (35, 53).
- (f) Intermittent fluoroscopic control of Ledoux-Lebard. Intermittent fluoroscopy using bonnet fluoroscope (16).

##### II. Single Tube Shift Principle.

- (a) Single Tube Shift, two exposures on one film (59, 62, 77, 101, 117, 135).
- (b) Single tube shift with Mechanical Triangulation (35, 54, 137). Many variations and reports of the principle include: Levy-Dorn and Gerard (35); Buguet and Gascar (35); Harrison (76); Turner (136); Wagg (139); Mergier—same principle but used two tubes instead of shifting one (35); Galeassi—with direct reading scale (35); Guilloz (35); Perdu (35); Muller (35); Kreuzfuchs (35); Manuel and Nogueras (35); Jaugeas (35); Charlier (35); Clark (36, 37); Colardeau (35); Coleschi (35); Cotton (41, 42); Davidson (46); Duncan (51); Hallam (70); Hampson (73, 74); Jallot and Guerra (35); Lagoutte (35); MacKenzie (96); Menard (35); D. R. Shearer (122); Stenning (129); Viallet and Dauvillier (35); Thurstan-Holland (134); Desplats (50); Laroquette and Lemaire (35); Mahar (35); Oram (109); Gamlen (61); Kirkwood (88); Deverre (35); J. S. Shearer (123).
- (c) Simple Tube Shift of Haret. Fluoroscopic method using tube shift and markings on screen with interpretation on triangulation (16).
- (d) Cross-thread Method of MacKenzie Davidson. Utilizes principle (a) plus use of cross-threads and necessity for reproduction by fixed reference—solved by triangulation (16, 43, 44, 45); also Hedley modification (78).
- (e) Granger Method. Single tube shift—fluoroscopic with special measuring device (64, 65, 66).
- (f) Remy Method. See Compass and Grid (VIII—h).

- (g) Little's Method apparently contains nothing not previously described—a direct reading scale for single tube shift and triangulation (91).
- (h) Localizing Profundoscope. Single tube shift with a special template in the fluoroscope screen (described in this paper).

### III. Double Tube Shift Principle.

- (a) Strohl Fixed-angle Method (described in this paper in detail, 54, 118).
- (b) Strohl Two-wire Method. A modification of (a) with reference points by opaque wires on tube head (101, 123, 137).
- (c) Davidson Method. A complicated cross-wire method using a permanent installation modification of the Strohl Method (47).
- (d) Cole Method (see IX—f).
- (e) Moppett Method. Double tube shift in a permanent installation with a series of lever attachments to support and move tube and screen in unison (106).

### IV. Two-plane Film Principle.

- (a) Two films at 90 degree angle to each other (59, 117); also White, Goodspeed, and L. Leonard (142); Stechow (35); Wilson (146).
- (b) See Bi-plane fluoroscopy with permanent record films.

### V. Parallax Principle (123, 137).

- (a) The localization of a foreign body by observation of the shadow upon the fluoroscopic screen while the tube is moving at determined distances from the body.

*or*

- (b) The image cast by an object on a fluoroscopic screen moves less and less as the object gets nearer the screen.

### *Methods*

- (a) Blaine Method. Parallax Principle with special opaque markers on a calibrated stand; commonly called Double Ring Method (9).
- (b) Redner Method. Similar to (a); employs double rings (35).
- (c) Young Parallax Method. A duplication of previously reported method by Le Faguays (35, 147).
- (d) Nearest Point Method. Use of opaque tipped rod to move foreign body; the nearest point causes the greatest movement (54, 75, 77, 118, 137, 141).
- (e) Method of Le Faguays. Pure Parallax—not presented in English (see Young).
- (f) Shenton Method. Pure Parallax (126, 127).
- (g) Parallax Principle also discussed by: Levy-Dorn (35); Exener (35); Angerer (35); Sherwald (35); Jordan (86); Le Faguays (35); Pirie (114); Grandgerard (35).

*Notes.*—The Nearest Point Method was first described by Wildt (35), later by Holzknecht (35) and Harris (75). It will be seen that many methods revert eventually to the Parallax Principle. They are considered in this study, however, on the basis of their most outstanding or revolutionary feature. Upon study, many methods described as Parallax Principle are found to be in some other class.

### VI. Opaque Instrument Invasion of Wound Principle.

- (a) Sutton Cannula and Trochar with Harpoon. Localization by trochar and cannula under the fluoroscope—harpoon is introduced and bent to the skin

for aid to surgeon (16, 54, 94, 128, 130, 137).

- (b) Profunda Method. A direct operative procedure under the fluoroscope for guidance. Forceps are directed straight downward in plane of central ray to grasp the object (54).
- (c) Profunda Method Modified by Parallax. A combination of the two methods used in instances in which the lateral approach is indicated (54, 118).
- (d) Bruce's Compass with Needle in Tissue. Modification of Sutton Method (24, 25, 35).
- (e) Flint's Band and Guide. Opaque strip about the body of patient and a V-shaped indentation to invade the wound at the site of the foreign body (56, 57).
- (f) Perthes' "*fromdkoerperpunktion*" (35).

#### VII. Localization by Reference to Opaque Bodies on the Skin.

- (a) Flint Profondometer. Credited to Irwin. Any opaque flexible material in bands moulded to skin and used as a reference point (16, 54, 56, 57, 137).
- (b) Tripod Band Guides. Modified Profondometer on a tripod support (16).
- (c) Bailey's Malleable Strip Method. Modification of the Profondometer in several planes (2, 35).
- (d) Blaine's Cross-section Anatomical Localization Method. Modification of Profondometer applied to anatomical cross-section charts (11).
- (e) Jordan Localizer. Two rods at 180 degrees on a vertical scale beneath a fluoroscopic screen (86).
- (f) Walsh Barium Wash. Small foreign bodies near the surface,

as a needle in the hand. The skin is washed in barium and identification made by position in regard to visible markings on the skin made by residual barium (118, 140).

- (g) Brown and Young Method. Reference to Bismuth-iodoform-paraffin paste in wound tract (21).
- (h) Multiple Opaque Rods of Caldwell. Reference to fixed multiple rods at angles to area of suspected foreign body (28, 35).
- (i) Direct Method of Morize. Utilizes Ring Pointer and four lead skin disks (Parallax, 16, 35); also Araujo (35).
- (j) Cole Method. (See IX—f.)
- (k) Warluzel and Jollant Method. (Probably first Profondometer method, 35).
- (l) Fox Method. Profondometer in Brain Localization (58).
- (m) Hernaman - Johnson Method. Four points on skin, Ring Localizer (85).
- (n) Lebon Method. Profondometer with bands and block of tin (35).
- (o) Belot, Fraudet, Nogier Method. Ring localizing method with special forceps (35).
- (p) Blaine Caliper Method. Use of calipers for reference (8).

#### VIII. Compasses and Grids Principle.

- (a) Blaine Parallax Method modified by a Ruled Celluloid Grid (137).
- (b) Hall-Edwards Grid. Ruled Grid for reference; direct reading (35, 71).
- (c) Dennis Fluorometer. Upright and Horizontal Grid on the fluoroscopic table with wood cuts-outs to support limbs (35, 48, 49).
- (d) Hirtz Compass. A complicated method with multiple opaque rods on a stationary compass (16, 54, 137).

- (e) Shearer's Permanent Installation of Hirtz Compass (124).
  - (f) Marion-Danier Localizer. Compass Method of using Mackenzie Davidson Principle (Single Tube Shift with Cross-threads, 16, 35).
  - (g) Debiegne's Compass. Arc bar and pointer for easy reference for the surgeon (16).
  - (h) Remy Method. Single tube shift—fluoroscopic—with two set compass directors; for use on the operating table (116).
  - (i) Shaxby Ladder Grid. Similar to Dennis Fluorometer (35, 120, 121).
  - (j) Tousey's Grid Method. A continuation of older grid methods (35, 133).
  - (k) Stenning Localizer Mat. A grid method with wires in a mat for reference (35, 129).
  - (l) Secheyay Grid Method. Complex in the extreme; much mathematics. Also described by Van der Goot (35).
  - (m) Contremoulins Compass. The forerunner of the Hirtz (35).
  - (n) Kocher Compass. No new principle; guide for surgeon (35).
  - (o) de Laroquette Compass. A simplified Hirtz but correspondingly less useful (35).
  - (p) Loro Radiological Sextant. Reference device (35).
  - (q) Marechal Compass. For operative guidance (35).
  - (r) Modifications of Hirtz Compass by; Chaperon and Vanderhaeger, Charlier, Morin, H. Bécère (35).
  - (s) Aime Method. Hirtz Compass with fluoroscope (35).
  - (t) Shaver and Simpson Method. Single tube shift with grid above patient, fluoroscopic and film method with wall charts (119).
- IX. Combination of Two or More Principles.
- (a) Thompson Method. Two-plane fluoroscopy with simple triangulation and the use of a special measuring device with opaque wires (132).
  - (b) Hall-Edwards Method. Two-film, single tube shift with definitely placed opaque markers—may be read either stereoscopically or by measurement (35, 72).
  - (c) Desplats Method. Single tube shift and return excursion with opaque markers on skin. Two marks on the screen with each shift. Correction and measuring done at room light (50). Modification. (See X—k.)
  - (d) Two-axis Method of Debiegne. Uses multiple skin marks on separate views. Requires moving patient (50).
  - (e) Combined Profunda and Parallax. (See VI—c.)
  - (f) Cole's Double Tube Shift and Triangulation with Use of Profundometer (35, 39).
  - (g) Jordan's Equal Shadow Shift. Combines Parallax, two opaque rods, and double tube shift (16, 86).
  - (h) FitzWilliams Method. Used Nearest Point followed by Profunda Method of Removal (55).
- X. Miscellaneous Methods and Devices.
- (a) Stereoscopic Films.
    - (1) Beck and Smith (5, 54, 77, 6).
    - (2) Imbert and Bertin (35).
    - (3) E. Thompson (35).
    - (4) Marie and Ribaut (35).
    - (5) Lambertz (35).
    - (6) Carothers (35).
    - (7) Bouchacourt (35).
    - (8) Gillet (35).
    - (9) H. Bécère (35).
    - (10) Mayer (35).
    - (11) Colombo (35).

- (12) Ribaut and Brock (35).
- (13) Buchbinder (26); also used opaque markers with stereoscope.
- (14) Iles (83).
- (b) Caldwell's Calipers (28, 35).
- (c) Little's Calipers (92).
- (d) Blake's Triangulation Method. A complex mathematical process of reporting other principles (15, 35).
- (e) Cardboard Cut-outs of Vergeley. A method of translation of findings by other methods (16).
- (f) Bramwell Arithmetical Aid. An aid, not a method (19, 35).
- (g) Hedley's Telephonic Probe (35).
- (h) Thomas Instrument. (Similar to g, 131).
- (i) Barclay Bell-ringing Forceps Localizer (3, 35).
- (j) Anatomical Localizations and Orthodiagrams—many methods. Desplats (50); Moritz (35); Herrman (80).
- (k) Desplats Caliper Modification of Own Method. Uses calipers instead of turning patient (50).
- (l) Central Ray Localization. A discussion of basic principle (16).
  - (1) Barrell Metal Cylinder Method (4, 35, 28).
  - (2) Blake's Modification of Barrell Method (12, 13, 14, 35).
- (m) Carver's Method. A reverse modification of the Single Tube Shift Principle in that the tube remains stationary but an opaque pointer is moved and the shift of it measured. The vertical ray is one reference point (16, 34).
- (n) Blaine's New Holder for Trochar and Harpoon Localizer. A modified Wedel needle holder for holding the cannula (10).
- (o) Busby Method. A three-position tube shift with special modifications of Dessane's Fluoroscopic Screen with cross-wires and marking device for the skin. Opaque markers on the skin and direct reading scale (27).
- (p) Formula of Buget and Cascar:
$$\text{Depth} = \frac{b \times h}{a + b}$$

a, Tube distance.  
b, Shadow shift.  
h, Height screen-anode.  
Later by Bermbach (35).
- (q) Wentzlik Method. A small chain and silver nitrate marks on the skin for reference (35).
- (r) Caleazzi Method. A pierced fluoroscopic screen for marking the skin through the hole (35).
- (s) Preventograph of Addymann. Really a simple ring localizer (35).
- (t) Furstenuau Calipers. A direct reading method. Described by Reichmann (115).
- (u) Coon Method. A method for civil practice (35).
- (v) Manges Method. In Roentgen Pelvimetry, suggests its use in foreign body work (35).
- (w) Wullyamoz Forceps. Blades at right angles to shaft to protect the operator from the roentgen rays. Also described by Laval (35).
- (x) Raoult-Deslongchamps Method. A fluoroscopic method with one eye control while the other eye watches the surgical field (35).
- (y) Le Nestour suggested a tent for the anesthetist so that the operative field could be kept dark (35). (He seems to have overlooked the surgeon.)
- (z) Baese Method. The tube and screen move together (35).
- (aa) Lefort Magnetic Guidance under fluoroscopic control (35).

- (ab) Castelvechio and Pittarelli Method. Complex mathematical calculations; no advantage over previous methods (35).  
 (ac) Kaufmann Method. For long,

89, 90, 91, 93, 95, 99, 105, 108, 110, 111, 112, 114, 125, 143, 144, 145).

*Note.*—It is obvious that many methods have been described which are duplications of previous work. It is possible

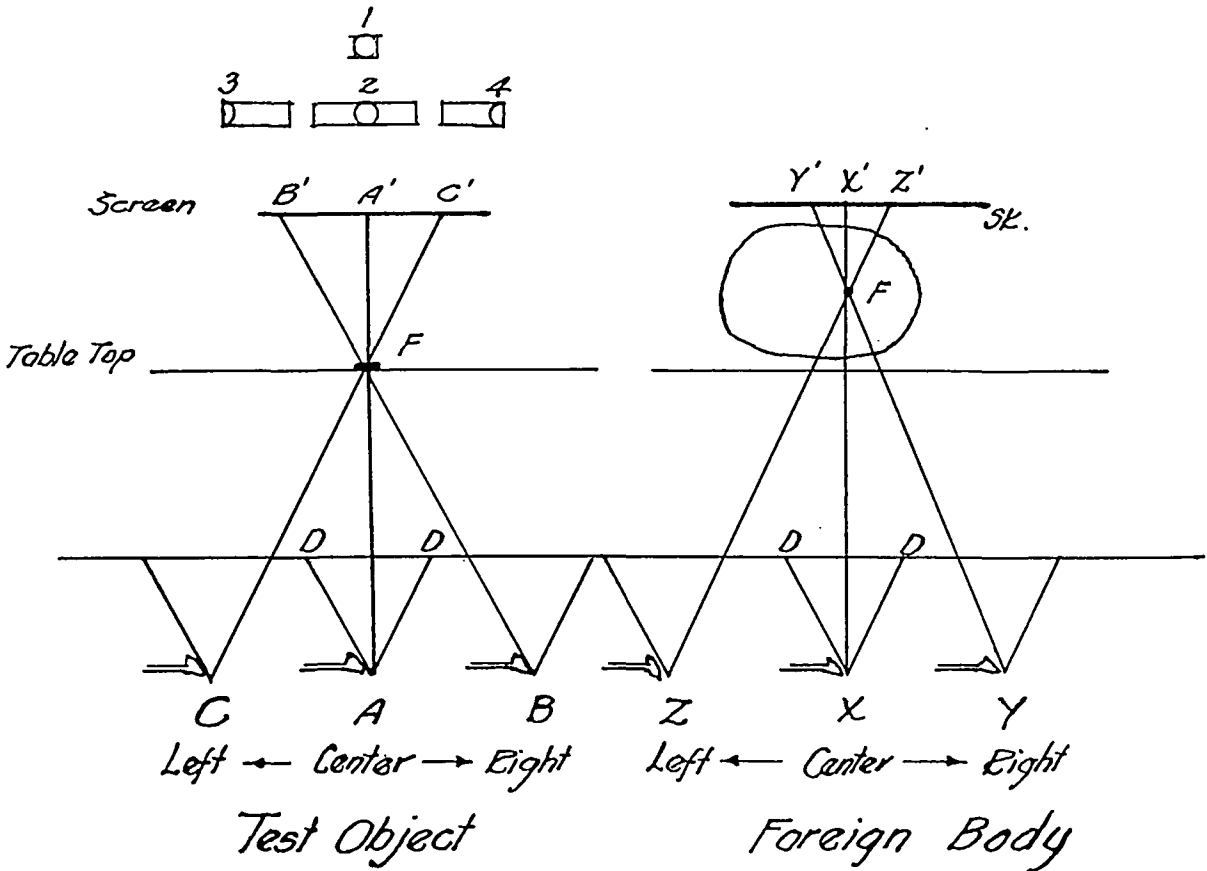


Fig. 1. Strohl fixed angle method.

slender, opaque bodies. A magnetic removal with a mathematical calculation (87).

- (ad) Ledoux-Lebard has used thermo-cautery for skin marking (35).

*Case Reports.*—By Aldridge (1); Bowker (17); Brissande and Londe (20); Bruce (23); Gray (67); Marsh (98); McCausland (100); Morris (107); Phelps (113); Griffith and Pearse (69); Herring (79).

*General Discussions.*—By Reference (7, 18, 22, 32, 38, 40, 52, 60, 63, 68, 82, 84,

that some method may have been inadvertently overlooked in our search. We will appreciate any information from readers of such an omission, so that the record may be made complete.

Classification has been attempted on the basis of the most outstanding or most revolutionary method involved. This was done for ease in reference.

*Due to the fact that the Strohl Double Tube Shift Two-wire Method has been shown to be the only method to survive the elimination process of the instruction literature of the U. S. Army, it is herein described.*



# STROHL TWO-WIRE DOUBLE TUBE SHIFT METHOD

This method is based on the Strohl Fixed Angle Method here noted as described in the *Outline of Radiology* of the Pennsylvania Radiological Society (54). Fixed Angle Method of Strohl.

## (A) Double tube shift method with mechanical triangulation.

1. Center tube to test object lying on table top.
2. Open slit to maximum width on fluoroscope diaphragm.
3. Displace tube toward right end of slit until margin of diaphragm  $D$  coincided with object; mark position on screen with wax pencil  $B$ .
4. Displace tube to left end of slit until margin of diaphragm coincides with object; mark on screen  $C$ .
5. The ratio of the distance of these two marks on the screen to the actual measured distance of the table top to the screen may be used in all subsequent localizations.
6. To localize foreign body in the tissue, go through similar procedure; shift right and left. By this means two similar triangles are obtained:  $B'TC'$  and  $Y'FZ'$  where  $Y'$  and  $Z'$  equal points on screen, right and left, and  $F$  equals position of foreign body.
7. In similar triangles the ratio of base to the altitude of one is equal to the ratio of base to altitude of the other and since three of these values can be measured it can be solved for the fourth, or the depth of the foreign body from the screen.
8. If skin is not in contact with screen measurement allowance must be made.

The two-wire method is a modification of this in which a sheet of transparent material, with two lead or steel wires

fastened at a fixed distance apart (4 in.), and placed at a fixed distance of 6 in. from the tube target, is attached to the shock-proof head of the fluoroscope. These wires are used as reference points for limit of beams.

The interpretation requires calculation but can be aided by a special rule or screen markings.

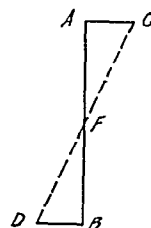
The consensus of opinion of both the military text books and of civilian authorities gives both the preceding method and the Single Tube Shift with Triangulation the highest number of votes by far, and since the Localizing Profundoscope, the method approved in this study, is based on a modification of the latter method in principle, it is here described in detail.

## SINGLE TUBE SHIFT WITH TRIANGULATION (135, 101)

### (A) Method.

1. Prone position — locate foreign body by fluoroscope.
2. Skin mark exactly over foreign body (must have shutters closed to a 2-in. square).
3. Place film under patient; 25-in. focal film distance. Center tube by light beam over skin mark.
4. Make exposure (light) one-third time for usual Bucky.
5. Shift tube 6 in. horizontally, make second exposure same film.
6. Draw diagrams—paper 30 × 12 in.  
Draw  $AB$ —25 in.  
Draw  $AC$ —6 in.  
Measure  $DB$  (distance between film images).  
Draw  $CD$ .  
Measure  $BF$  depth of foreign body in patient measured from skin surface nearest the film.

$AB = 25$  in.  
 $AC = 6$  in.  
 $DB =$  measure on film  
 $FB =$  depth of foreign body



*Note.*—This is *not* the point of the mark on the skin, but is just the opposite side of the body.

(B) Apparatus.

1. Fluoroscope.
2. Film equipment.
3. Skin marker.
4. Paper for computations.
5. Chart for depth curves.

(C) Accuracy of localization depends on:

1. Care of centering tube.
2. Care in plotting diagram.
3. Care in measuring two foreign body images.
4. Absolute immobility of patient.
5. Remembering that spot on skin is not the localization point for surgeon. (Grave danger here.)
6. Absolute suspension of motion, to include respiration, also necessary (Rhinehart, 117).

From the description it can be seen that a good method of permanent localization record can be obtained. However, the procurement plan of the Army for an emergency does not call for any work except fluoroscopy in forward installations of the Medical Department. Therefore, it was necessary for a method to be developed which could be applied to this situation and yet meet all the other requirements outlined previously in this paper. The Localizing Profundoscope as developed by Sergeant Black was the outcome, and it is described in this paper. It is believed that this method will eliminate the necessity of all other methods in this work.

PRESENT RECOMMENDATIONS OF THE  
SURGEON GENERAL'S OFFICE FOR FOREIGN  
BODY LOCALIZATION

As a basis for approval or rejection of any method for use in the U. S. Army, the following points have been listed as essentials to an efficient method of localization of foreign bodies in time of war:

1. Speed.

Patient turn-over is rapid and evacuation must go on.

2. Accuracy.

Unless the exact location of the fragment can be given to the surgeon, the time used in radiography is poorly spent.

3. Simplicity.

(A) Of equipment.

Each additional piece of equipment is an added hazard to loss of function due to loss or destruction of parts. Within reason, parts must be replaceable on the field or a working substitute produced. Weight and bulk are important in mobility.

(B) Of operation.

A minimum of measurements and mathematical computations essential, due to fatigue and nervous factors of operators under stress. Manipulations should not require an undue amount of skill.

4. Fluoroscopy sufficient.

The present plan for equipment in forward medical installations allows for fluoroscopy alone.

5. Comfort of patient important, including a minimum of manipulation and position changes.

Conversely, the violation of the following factors make the system subject for rejection:

1. Necessity for reading fine scales.
2. Necessity for reading any scale in a bad light.
3. Necessity of making many calculations.
4. Necessity of drawing diagrams.
5. Necessity of changing the light intensity of the room.

*General Considerations for Good Work in Localization of Foreign Bodies.*—As in all branches of roentgenology, the principles of good work apply in this endeavor. Since the majority of present-day accepted methods are largely fluoroscopic, the operator must insist that—

1. A properly darkened room be obtainable.

2. Proper time be allowed for eye accommodation.
3. Patient is prepared before entrance to fluoroscopic room.
4. Preliminary examination of suspicious areas be performed in a good light and report accompany patient.
5. Apparatus is adequate and in good working order immediately prior to examination.
6. Any accessories necessary are conveniently at hand and in good working order.
7. Assistants are properly trained and act promptly and efficiently.
8. Part to be examined is placed within the

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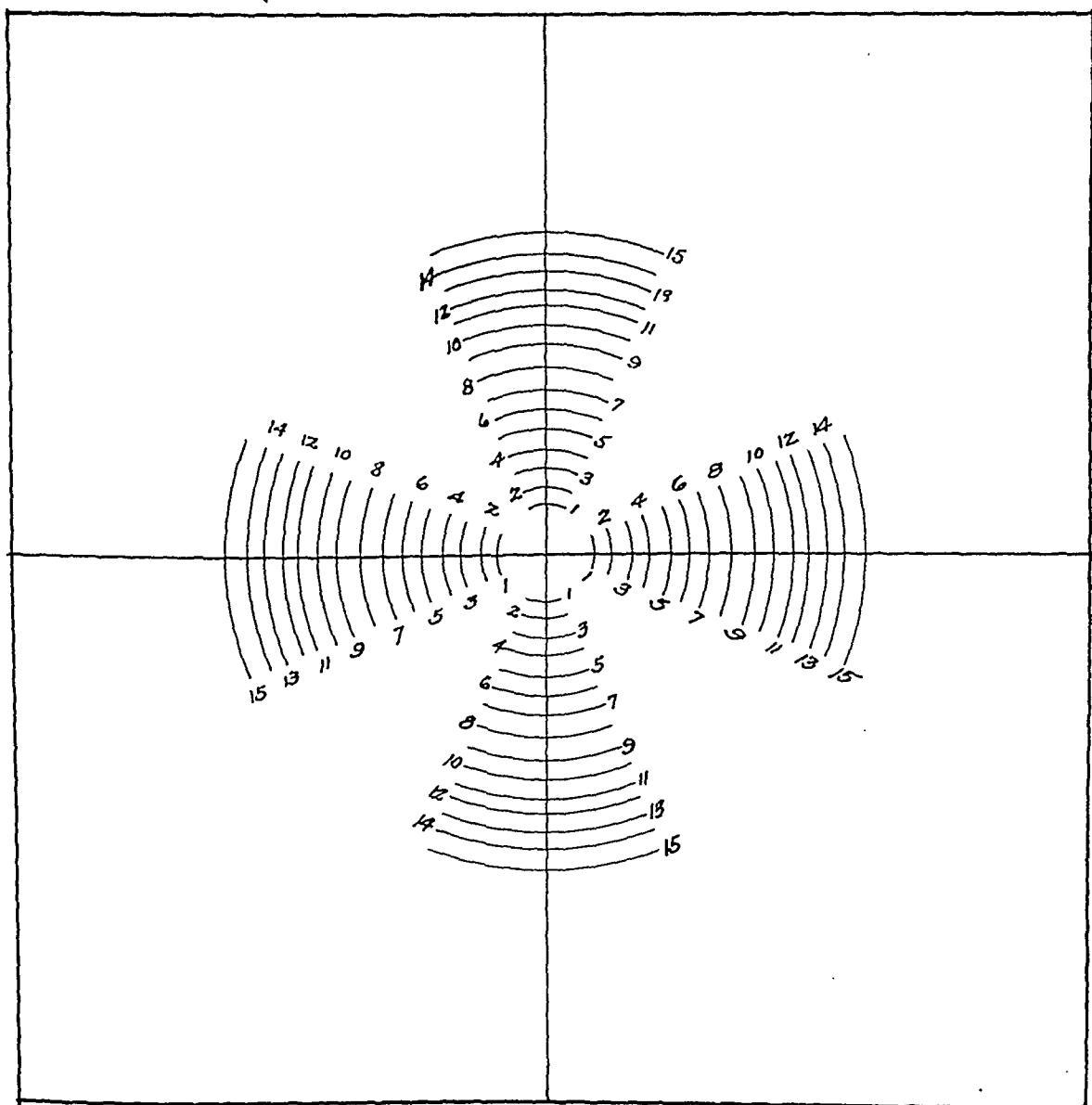


Fig. 2. Device for localization of foreign bodies.

- (H) Note negative findings as: free from projectiles, not free from wounds.

#### THE LOCALIZING PROFONDOSCOPE

##### (A) Apparatus.

1. A transparent template 25 cm. square. (Best material  $\frac{1}{8}$  in. thick lucite—Du Pont, diagram A).

Directions for rule:

- (a) Find exact center by cross-hairs from the corners.
  - (b) Inscribe cross-lines vertically and horizontally and center point.
  - (c) With dividers inscribe concentric arcs on each cross-quadrant line  $\frac{1}{3}$  cm. apart, beginning at a point on the cross-quadrant line equal to the vertical measurement of the marking device from its tip to the top of the screen.
  - (d) Place on fluoroscope screen.
2. The X-ray Equipment.  
A fluoroscope with the tube mounted beneath the table, screen above. The anode of the tube must be exactly 30 cm. from the table top (Diagram B).
  3. A special cone must be attached to the fluoroscopic head, the base of which will form an angle of 36 degrees, with the apex at the anode (Diagram B). This angle is of the utmost importance.

This special cone must be accurately centered above the tube so that the apex of the cone angle is exactly placed at the focal spot of the tube. The reason for this is the extreme importance of the relation between the template markings and the cone angle ratio.

4. Marker insert beneath screen. A piece of cork in the form of a rectangular ring (measurements with a skin pen suspended inside) is placed beneath the center of the insert and screen (Diagram D).

The marking on the insert is cali-

brated to allow for this extra depth.

##### (B) Method.

1. Find the foreign body and localize preliminarily to near the center of the screen.
2. Close the fluoroscopic shutter to its smallest opening, exactly aligning the intersection of the cross-quadrant lines, the foreign body, and the anode of the tube in a vertical plane.
3. Shift the tube off-center until the center of the foreign body shadow on the screen goes outside the field of visual illumination caused by the cone on the tube head (Diagram C).
4. The actual depth of the foreign body in centimeters is the figure on the insert where the edge of the visual field intersects the shadow of the foreign body.
5. All reading on this insert is actual depth from the surface of the skin to the foreign body and not from the screen.

#### CONCLUSIONS

1. A review of the subject of foreign body localization is made.
2. The procedure recommended by the Surgeon General's Office, U. S. Army, is outlined.
3. A new method (the Localizing Profundoscope) of extreme simplicity and accuracy, which can be used under any circumstances where x-rays are available is offered.

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\* No attempt has been made to include in this the many fine articles written in languages other than English.

In compiling this work an attempt has been made to find all English references; some, however, have probably escaped us. It will be deeply appreciated if the reader will notify us of any reference inadvertently passed over so that the record may be made complete.

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# A ROENTGEN PELVIMETER SIMPLIFYING THOMS' METHOD

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SOON after the discovery of the x-ray by Roentgen in 1895 one of the practical uses first thought of was the exact measurement of the pelvic inlet for obstetrics. Because of the divergence of the rays and the subsequent enlargement of the image on the radiograph, methods for compensation were devised before 1900. One of the simplest of these consisted of a string belt of lead beads 1 cm. apart, which was worn by the patient around the pelvis so that it lay in the plane of the superior strait. The distance on the radiograph between the images of adjacent lead pellets then represented 1 cm. in the superior strait. Keeping this factor in mind, any measurement of the inlet could be calculated.

Herbert Thoms (2), of America, has improved on this idea and over the last twenty years has developed the scale or grid method. This consists essentially of radiographing the pelvic inlet as nearly parallel to the film as possible and then the patient is removed and an opaque perforated plate, with small holes at centimeter intervals, is placed in the plane of the superior strait. A second short exposure is then given with tube and film in the same position as at first. The rays which penetrate the small holes print black dots on the previously exposed film.

Because of the distortion this distance between neighboring dots is more than 1 cm. and may be 1.5 cm., but it represents actually 1 cm. in the pelvic image; by

counting the spaces anteroposteriorly and laterally across the pelvic inlet the exact measurement, within small limits, is read without any calculation (3).

The clinical value of the method lies in its presentation of most of the essential factors in the obstetric study of the pelvis (first), direct actual measurements of all diameters of the inlet (second), and this is almost as important as the first, the contour of the pelvic inlet. Caldwell and Moloy say, "The absolute pelvic type depends on the shape of the inlet." This second finding gives information invaluable in prognosis and in relation to the recent trend to classify the female pelvis into essentially the four groups (a) gynecoid, (b) anthropoid, (c) android, and (d) platypelloid, of which the modern exponents are Caldwell and Moloy (4), Thoms, and others.

This method has been endorsed by many scientific students of pelvimetry as accurate and reliable (3). However, its widespread adoption has been hindered by the difficulty of fixing in space the plane of the superior strait, a procedure which is necessary. In the Thoms method a plumb bob is hung to mark that of the symphysis pubis and after the patient is off the table the perforated plate is placed in the proper plane by measuring the distance and height of the opposite end of the external conjugate (Baudelocque diameter). This must be done accurately and it requires considerable time by an expert.

The device herein described and illustrated simplifies the method to such an extent that any technician may learn quickly to complete the total process within ten minutes. It consists essentially of a portable platform to fit the surface of the x-ray machine (Fig. 1). From the middle of the platform at about a 45°

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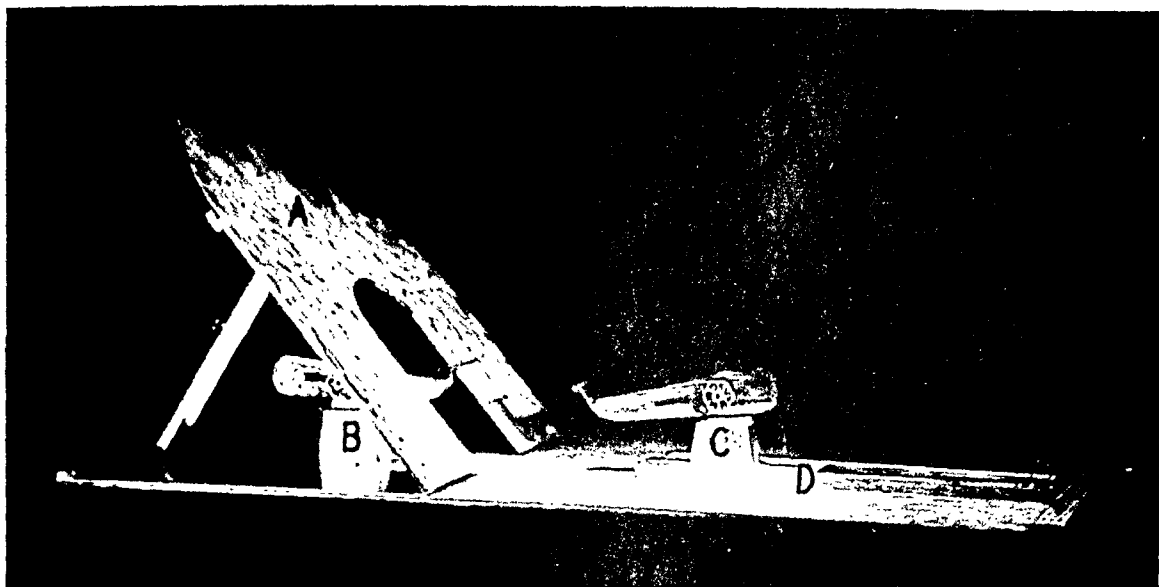


Fig. 1. Sectional photograph of roentgen pelvimeter. *A*, backrest with device to alter the angle; *B*, posterior post fixed to platform; *C*, anterior post mounted on a sliding plane, *D*, so that after adjusting the movable arm the post can be temporarily moved away so that the patient may get off the table. After she has been roentgenographed the post is shifted back into place and the two cross-arms then mark in space the plane of the superior strait. The perforated plate is laid over them and the second exposure made.

angle rises a backrest with an opening in the lower central portion. To the rear of the backrest a post is fixed to the platform base and from this rises a movable arm with a 5-inch transverse marker. This marker may be fixed in an arbitrary position at the posterior end of the patient's external conjugate—at the space between the fourth and fifth vertebral spines. On the front of the platform for marking the point at the anterior end of the external conjugate (1 cm. below the top of the symphysis pubis) is a post on a sliding frame. This also has a similar arm with a narrower transverse marker which, when the post is as near the patient as it will slide, is fixed against the patient 1 cm. below the top of the symphysis pubis.

With the patient sitting on the platform, leaning against the backrest and the markers fixed, posterior one at 4-5 lumbar space, anterior one 1 cm. below the top of the symphysis pubis, the film is exposed. For non-pregnant women we have found the following technic satisfactory: Bucky diaphragm, 36 in. tube-cassette distance, 80 kv., 15 milliamperes, 15-25 seconds' exposure. For full-term pregnant cases,

same setting, 20-35 seconds' exposure. It greatly improves the roentgenogram if the cathode is toward the patient's head, the tube parallel with her body, and the anode toward her feet. Otherwise the promontory half of the film is likely to be underexposed. Inasmuch as the patient is fixed by this device with regard to the position of the pelvic inlet, a very small film (we use routinely 8 × 10) may be used.

After the exposure of the patient is made, the sliding post is shifted forward without loosening the fixed arm marker. This allows room for the patient to climb off the table, after which the sliding post is pushed back to the position of the first exposure. Now, with the tube and film in the same position the lead plate (its central area is perforated with a small hole every centimeter in both directions) is placed to lie across the two fixed markers. (Note: If the pelvis is tilted the method is still accurate because the lead plate is equally tilted.) A second flash exposure, of one-twentieth of a second, is then made, printing the dots over the previously exposed film. Counting the spaces between

dots anteroposteriorly and transversally gives directly the two diameters in centimeters.

Outline of the pelvic inlet indicates the type of pelvis. If the anteroposterior is less than the transverse, gynecoid; if the anteroposterior is equal to or slightly greater than the transverse, anthropoid; if the opening is roughly triangular, android; if there is marked flatness, platypelloid (4). If the physician is not satisfied from the single film as above, he may have further study made of the sacral contour and of the outlet including the lateral film which Thoms has recently advocated. However, we have not found further x-ray study to be of any great value but have been very well satisfied with a single  $8 \times 10$  film in the study of the pelvis of the doubtful cases of 1,600 pregnancies and deliveries in the last two years in which this device has been in use. As suggested by Caldwell and Moloy, we rely upon palpation of the sacrum and the width of the subpubic angle for additional facts, and these should be part of the information to be sought in every rectal or vaginal examination.

The outstanding finding has been the large percentage of patients, both colored and white, with normal or essentially normal pelvis. We have found that practically all patients with more than 9 cm. true conjugate diameter will deliver spontaneously or with low forceps. Among 2,000 women we have found only five or six with anteroposterior diameters less than 9.5 and one of these was a dwarf and one a case of traumatic scoliosis. We are of the opinion that such a roentgenogram of every patient whose ability to deliver, even after labor is in progress, is questioned would be of greatest value in reducing the prevalent high incidence of cesarean section based on erroneous diagnosis of contracted pelvis.

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## EXCRETORY UROGRAPHY BY THE INTRAMUSCULAR INJECTION OF DIODRAST

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EXCRETORY urography, by way of intravenous administration of diodrast (Winthrop), hippuran (Mallinckrodt), or neo-iopax (Schering), is well established. It is receiving increased use by the roentgenologist, internist, pediatrician, general practitioner, and urologist. The usefulness of excretory urography can be extended by making the procedure available in cases in which intravenous administration is difficult or impractical; such as in infants and children, or in adults with buried or blocked veins.

Diodrast (Winthrop), a 35 per cent solution of iopyracil, has been administered intramuscularly at the University of Nebraska and Nebraska Methodist Hospitals in a series of 18 patients, 10 of whom were children. Good visualization of renal pelvises, calices, and ureters, almost equal to the concentration seen following intravenous administration, resulted in nearly all cases. No complications or untoward results have been noted in any patients.

### HISTORY

Von Lichtenberg and Swick (14), in 1929, were the first to make excretory urography a practical procedure by intravenous injection of uroselectan. Butzengeiger (3), in 1931, used skiodan subcutaneously. He injected 20 grams of the drug in a 500 c.c. solution into each axilla as a hypodermoclysis. A report was made on 30 cases which showed this procedure to be almost as satisfactory as intravenous injection. The patients suffered no local reaction or sloughing and experienced only the discomfort of the actual administration of the skiodan. Hillebrand (5), in 1932, gave skiodan subcutaneously to children. He used 100 c.c. of a 4 per cent solution and the visualization was highly satisfactory. Swick (12), 1933, reported diag-

nostic urograms two hours after ingestion of 15 grams of hippuran in syrup, although in our experience visualization has been entirely inadequate by this method. Beer and Theodore (1), 1934, gave neoskiodan by hypodermoclysis to 15 patients, 10 of whom were children. Fairly satisfactory shadows were obtained from 50 to 60 minutes after administration of the drug. Senger and Ruggiero (10), 1936, reported diagnostic excretory urograms following subcutaneous injection of 10 per cent skiodan. Dreyfus and also Perman and Lichtenstein (9) used 7.5 per cent perabrodil subcutaneously with good results. Travis (13), 1937, obtained good urograms with no untoward results following subcutaneous injection of 80 c.c. of 9 per cent diodrast in 18 children between the ages of three weeks and nine years.

Our procedure has differed from those previously used, in two particulars: (1) the diodrast was used in 35 per cent solution in all cases instead of in an isotonic solution; (2) the solution of diodrast was injected intramuscularly into the gluteal region instead of subcutaneously. No superiority of roentgenograms is claimed for these innovations although the procedure is safe and can be rapidly and conveniently executed. We wish to emphasize that we are not recommending the intramuscular injection of any of the various excretable radiopaque drugs other than diodrast.

### MERITS OF EXCRETORY UROGRAPHY

The pediatrician and the child have benefited greatly from excretory urography (Campbell, 4, Hyman, 6, Perman and Lichtenstein, 9). Retrograde pyelography is difficult in male infants and at times it may be impractical to pass a cystoscope through the small urethra. At least, it is taxing and not without danger to the pa-

tient. A general anesthetic is usually necessary, introducing the possibility of complicating sequelæ. Roentgenograms made during general anesthesia are blurred by breathing and often unsatisfactory. Added expense is incurred due to the desirability of hospitalization.

Excretory urography in children is of great value in the case with recurrent infection along the urinary tract, persistent pyuria, or an obscure fever of unexplained origin. Recurrent pyelitis is usually due to some developmental abnormality in the urinary tract or other mechanical interference with the passage of urine from the kidneys or bladder. Excretory urography is of great value in these cases for two reasons: (1) congenital anomalies are often shown which might not be demonstrated by retrograde pyelography; (2) the extent of the functional and structural impairment of the kidney is well demonstrated. Abdominal tumors in children are frequently renal in origin and urography is most helpful in the determination of the site of origin and the extent of the lesion. Too frequently no pyelographic or urographic x-ray studies are made in children with recurrent pyelitis because cystoscopy is a dreaded procedure and intravenous administration of excretable contrast solutions is difficult or impractical. The intramuscular use of diodrast provides a safe and practical method for demonstration of the renal pelves and calices without regard for the uncertainties of venepuncture in children.

The urologist frequently encounters problems in which excretory urography is essential or advisable. Passage of the cystoscope may be impractical due to stricture or narrowing of the urethra. In some cases the expert cystoscopist is unable to pass a catheter up one ureter due to obscuration of its orifice at the bladder or obstruction of the ureter itself. Two kidneys and double or branched ureters occasionally occur, in which case the retrograde catheter enters only one branch of the ureter with only partial visualization in the pyelogram. In the above cases an

excretory urogram will show valuable information which cannot be provided by the retrograde pyelogram. Supposed rupture of a kidney makes excretory urography preferable to retrograde pyelography due to reduced possibility of infection, minimum shock, and speeding of information.

#### LIMITATIONS OF EXCRETORY UROGRAPHY

The limitations of excretory urography are well established. The procedure is of little or no value to the patient who shows grossly impaired renal function, or in whom fine delineation of pyelographic detail is essential for differential diagnosis, such as in early tuberculosis or questionable neoplasm. It is contra-indicated in cases of severe liver damage, advanced nephritis, and uremia. It must be used with care in tuberculosis and hyperthyroidism. Renal function can be impaired by pyelonephritis, congenital polycystic disease, obstruction, nephritis, or reflex inhibition of excretion. In case the excretion of phenolsulphonphthalein is under 10 per cent (normal 65 per cent), in two hours excretory urograms will be unsatisfactory by any method. Cases with moderate impairment of renal function may show some visualization after one to two hours. A dilated renal pelvis requires a longer interval, one to four hours, to accumulate sufficient iodide for visualization. The interval spacing of films must be correlated with renal function and with the clinical problem, if satisfactory excretory urograms are to be obtained.

#### TECHNICAL PROCEDURES

Clear demonstration of renal pelves, calices, and ureters by excretory urography demands maximum concentration of iodide, freedom from overlaying gas, retention of excreted iodide in pelves and ureters, brilliant contrast, complete immobilization, and sharp definition. Thorough preparation of the patient and the best roentgenographic technic are therefore absolutely

essential. The urographic concentration of diodrast obtained by the intramuscular route is about 80 per cent of that resulting from the intravenous route. Concentration of iodide can be somewhat increased by dehydration from withholding food and drink during the previous twelve hours (Berger, 2). On the other hand, in urgent cases, satisfactory concentration is usually seen without this preliminary dehydration.

Obscuring intestinal shadows can be reduced by catharsis, enemas, and pitressin. The bowel can be cleansed of feces by castor oil, one to two ounces, given 12 hours previously. In more urgent cases a tap water enema of two quarts is given 20 minutes before roentgenography. This is followed immediately by 0.5 c.c. to 1 c.c. of pitressin before evacuation (Kenning and Lofstrom, 7), unless contra-indicated by cardiac decompensation, coronary disease, hypertension, complete intestinal obstruction, or pregnancy near term. The gas-expelling effect of the pitressin begins to wane after about 15 to 30 minutes. A preliminary "scout" film is always essential and it will show opaque calculi and the amount of residual gas. A pillow under the knees will often allow the lumbar curve to drop down nearer the film and improve detail. Injection of diodrast always provokes a further accumulation of gas after from 10 to 20 minutes, apparently due to lessened bowel tone. In case the gas becomes troublesome, it can be decreased in evidence by a further 0.5 to 1.0 c.c. of pitressin. A mild hypnotic such as phenobarbital (Perman and Lichtenstein, 9) aids the procedure by quieting the patient and reducing his discomfort during the prolonged, tedious examination.

Intramuscular injection of diodrast should be limited to cases in which intravenous administration is impractical due to small buried or blocked veins, or to an unco-operative, restless patient. The sterile tray for intramuscular injection carries a 2 c.c. syringe; a 26 gauge hypodermic needle; a 20 c.c. syringe; a 16 gauge needle for filling the syringe; two 23 gauge 2-inch infiltration needles with safety shank used

for intramuscular injection; a medicine glass; 2 per cent novocaine without adrenalin; 70 per cent alcohol, sponges, and diodrast. A flask of sterile distilled water should be at hand to allow dilution of diodrast to half strength in case the physician prefers a less hypertonic injection. A small cutaneous novocaine wheal is made in the upper outer quadrant of each buttock. The intramuscular needle is then directed superiorly and laterally into the gluteal region to avoid the sciatic nerve. The point of the needle is occasionally shifted slightly during the injection of diodrast to promote diffusion. The total quantity injected is from 10 to 20 c.c. in children, and from 20 to 30 c.c. in adults, divided between the right and left buttocks. In some cases we have drawn 1 c.c. of novocaine into the diodrast with relief of all discomfort during and following injection. Adrenalin in the novocaine would retard absorption by vasoconstriction. We have endeavored to hasten absorption in some cases by application of a hot water bottle to the buttocks.

Compression of the bladder and lower ureters improves visualization of renal pelves and calices (Kornblum, 8, Berger, 2) due to distention of the upper urinary tract by the retained iodized urine. Latent pyelectatic changes can be made apparent which would not be demonstrated without pressure and anatomic details are shown with more clarity. Urine in the bladder is no handicap in excretory pyelography and may aid by increasing ureteral back pressure. Compression also improves urograms by better immobilization and lessening of cardiovascular pulsations and other involuntary movements. The compression bag used by us is a 5-inch inflatable bag supplied by Picker with his gastro-intestinal compression belt. The collapsed bag is placed directly above the symphysis and a table compression band snugly drawn over it. The bag is then inflated to tolerance, being certain that it rides in the pelvis between the symphysis and sacral promontory. Pressure is usually applied directly following the first

urogram and kept in position until after the second urogram is exposed. In case particular attention is being directed to the lower ureters, the urogram should be made directly following release of the pressure.

renal pelvis. Absorption can be evaluated in the roentgenogram since the intragluteal diodrast is clearly demonstrated, as in Figs. 1-A-C. About 95 per cent of the diodrast is absorbed after two hours. An



Fig. 1-A.



Fig. 1-B.

Fig. 1-A. Case 1. Ten minutes following injection of 9 c.c. of diodrast into each gluteal region, showing good excretion by each kidney. Bowel was poorly prepared, no pitressin used.

Fig. 1-B. Case 1. Thirty minutes following intragluteal injection of diodrast, good concentration. Gross dilation of right renal pelvis with caliectasis. Normal left renal pelvis.

Optimum contrast and detail should be approached in the roentgenograms by relatively low kilovoltage, small diaphragm, Potter-Bucky grid, high milliamperage, short exposure time, adequate distance, and small focal spot.

The first roentgenogram following intramuscular injection can be made after an interval of ten minutes as a test of renal function. Excretion is sometimes evident within five minutes. Structural details are usually best shown with compression 30 to 45 minutes following intramuscular injection, depending on the rate of absorption, renal function, and capacity of

inadequate visualization after 60 minutes suggests impaired function or a dilated pelvis. Size and contour of the kidneys may be accentuated by the diodrast even though pelvis and calices are not discerned. Lack of concentration after two hours usually indicates gross impairment of renal function. We have checked some cases showing inadequate visualization following intramuscular injection of diodrast with parallel findings. In general one can roughly estimate the optimum time for the final urogram from the density of concentration prevailing in the ten-minute urogram.

## CASE REPORTS

The general adequacy of the method is suggested by the variety of lesions demonstrated. Our small series has included Wilms' tumors, ureteral obstruction, aber-



Fig. 1-C. Case 1. Two hours following intragluteal injection of diodrast, nearly complete absorption from glutei with persistent clear visualization. Note constriction at right ureteropelvic junction.

rant polar vessels, double ureters and other congenital abnormalities, as well as essentially normal urinary tracts. The first case shows progressive absorption of diodrast from muscles and rate of excretion in urine. It also shows the utility of intramuscular injection after failure of intravenous injection and frustration of retrograde pyelography.

Case 1. K. B., female, 5 years of age, was referred to the Nebraska Methodist Hospital, Nov. 6, 1936, by J. A. Henske, M.D., with a history of recurrent frequency, dysuria, pyuria and septic temperature for three months. An intravenous injection of diodrast was successfully



Fig. 2 (above). Case 2. Bilateral double ureters and kidneys. Slight caliectasis of right inferior kidney with dilation of its ureter. Urogram, 45 minutes following intragluteal injection of 20 c.c. of diodrast.

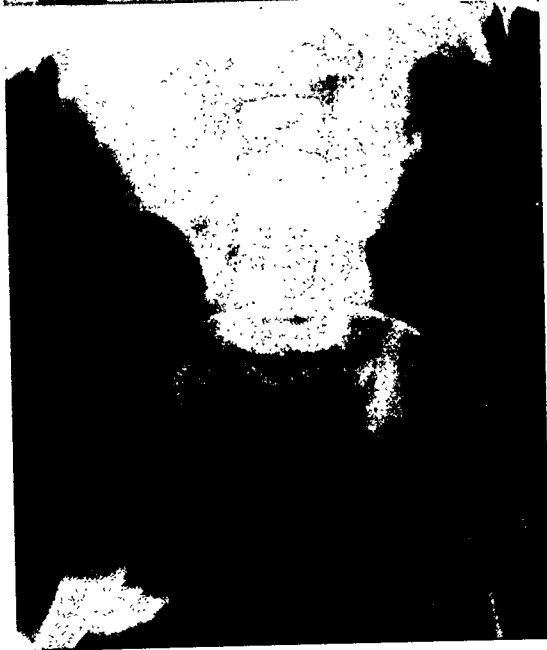


Fig. 3 (below). Case 3. Age 18 months. Ligation of right ureter during panhysterectomy for carcinoma of uterus. Urogram, 30 minutes after intragluteal injection of 20 c.c. of diodrast.

started but was interrupted by dislodgment of the needle after 2 c.c. The remaining 18 c.c. of 35 per cent diodrast was injected deeply into the right and left gluteal regions. There was a mild stinging

pain such as accompanies any voluminous injection but no residual pain, tenderness, or damage of tissue was noted at any time by careful examination.

Serial roentgenograms made after 10 minutes, 30 minutes, and after two hours show progressive absorption and sustained, concentrated urinary excretion of diodrast as shown in Figs. 1-A-C. The right kidney was five to six times the normal size with dilation of calices, pelvis, and ureter. There was definite constriction at the ureteropelvic junction. Catheterization of right ureter was prevented by obstruction. Nephrectomy was done by Edwin Davis, M.D., for intractable pyelitis, with uneventful convalescence.

The patient with mild to severe recurrent pyelitis deserves a urographic examination. Pyelitis commonly results from some interference with urinary drainage as in the above case. Double or branched ureters are frequently associated with some zone of ureteral stenosis which may lead to stasis, infection, pyelectasis, and ureterectasis as in the preceding and following cases.

Case 2. C. M. H., female, 6 years of age, admitted to the Nebraska Methodist Hospital, Nov. 11, 1937, seen with a known history of four severe attacks of pyelitis since 15 months of age, each attack lasting from 10 to 14 days with septic fever to 106° F. Following novocaine anesthesia of skin, 10 c.c. of 35 per cent diodrast containing 0.1 per cent novocaine was injected into each gluteal region with practically no pain and with no subsequent soreness. A cleansing enema and 1 c.c. pitressin were given subsequently to reduce gas.

Urographic studies made 45 minutes after injection showed bifurcation of each ureter in the region of the ureterovesical junction with associated double renal pelves. Right inferior caliectasis and ureterectasis became evident with ureteral compression (Fig. 2).

Complete obstruction of one ureter or a unilateral loss of renal function is readily demonstrated by intramuscular urography. The following case is worthy of note in it-



Fig. 4-A (above). Case 4. Large Wilms' tumor arising in superior lateral aspect of right kidney producing inferior displacement, with elongation and lateral compression of renal pelvis. Retrograde pyelogram.

Fig. 4-B (below). Case 4. Same Wilms' tumor, three months following x-ray therapy. Note recession of mass and relatively normal position and contour of right renal pelvis. Intramuscular excretory urogram at 30 minutes; compare with retrograde pyelogram, Fig. 4-A.



self, being a highly malignant carcinoma of the uterus in a baby 18 months of age.

Case 3. J. J., female, 18 months of age, referred to University Hospital, Dec. 28, 1937, by H. B. Hamilton, M.D., with his-

showed a residual degenerating embryonal carcino-sarcoma arising from the superior pole of the right kidney.

#### EXCRETORY RADIOPAQUE AGENTS

TABLE I

Drug	Amount	Volume	Concentration
Diodrast	7 gm.	20 c.c.	35 per cent
Hippuran	12 gm.	25 c.c.	50 per cent
Skiodan	20 gm.	50 c.c.	40 per cent
Neo-iopax	15 gm.	20 c.c.	75 per cent

tory of increasing vaginal bleeding for six weeks due to a highly malignant carcinoma of the uterus, 5 cm. in diameter, filling the pelvis and invading the upper vagina. Treatment consisted of panhysterectomy followed by 1,800 mgm.-hr. of radium. In view of possible ligation of a ureter, 10 c.c. of 35 per cent diodrast was injected deeply into each gluteal region. A urogram after 30 minutes showed a normal left kidney and ureter (Fig. 3). The right kidney showed no function, indicating ligation of ureter in this case.

Intramuscular excretory urography is usually adequate for the diagnosis of large renal tumors and provides a graphic check on the accomplishments of x-ray therapy in these cases. A small residual tumor may escape recognition even with retrograde pyelography.

Case 4. F. H., male, 3 years of age, admitted to University Hospital, April 10, 1937, with a history of loss of appetite, presented a tumor mass filling the entire right side of the abdomen. An excretory urogram showed elongation and lateral compression of the right renal pelvis. The pelvis was displaced inferiorly through 5 cm. by the 10 × 15 cm. soft tissue mass in the right upper quadrant. This distortion was confirmed by retrograde pyelography (Fig. 4-A). A check-up, intramuscular urogram, made three months following 2,000 roentgens anteriorly and posteriorly to the tumor, shows good renal function bilaterally, regression of the tumor and restoration of position and contour of the right pelvis to near normal (Fig. 4-B). Nephrectomy

The apparent lack of any pain or tissue damage following the intramuscular injection of 10 c.c. of standard strength diodrast into each gluteal region has amazed us. In case anybody is skeptical of the intramuscular injection of a strongly hypertonic solution of 35 per cent, as used by us, the solution may be diluted. We believe absorption and excretion would be practically as effective with dilution to one-half or one-fourth the concentration provided for intravenous use. Recent experimental studies indicate that subcutaneous injection gives equally or more rapid absorption and no more reaction than intramuscular injection. Histological study showed a very slight transient or usually no reaction 24 hours after 35 per cent diodrast. Induration and foreign body reaction nearly always follow injection of 70 per cent diodrast. The reaction is less severe and of shorter duration after subcutaneous injection.

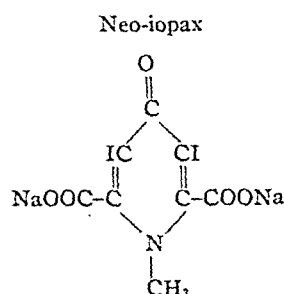
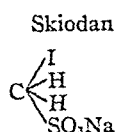
We have had no clinical experience with the intramuscular injection of any of the various other agents commonly employed for intravenous excretory urography: neo-iopax (Schering), skiodan (Winthrop), and hippuran (Mallinckrodt).

Diodrast possesses the advantages of the lowest concentration and the smallest volume with equivalent concentration. The excessive concentration of the standard preparations of these other agents made us fear severe pain, irritation, and possible sloughing although we have had no clinical experience with them. The chemical structure of these agents differs as shown by their formulæ and these differences may vary their biologic effects.

#### SUMMARY

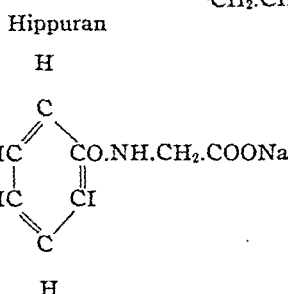
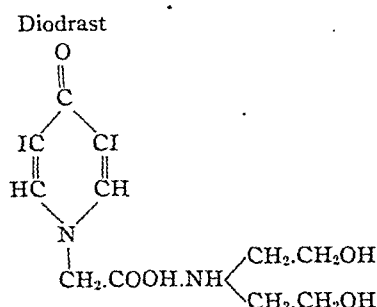
1. Excretory urography by hypodermic or intramuscular injection of 35 per cent

diodrast (Winthrop) has proven a safe and practical procedure in 18 patients, 10 of whom were children.



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2. Its use should be limited to cases in which intravenous injection is impractical due to small buried or blocked veins or due to lack of co-operation by the patient. Subcutaneous urography is particularly valuable in small children.

3. Concentration of iodide by the extra-vascular route is about 80 to 90 per cent that by the intravenous route and the time required for optimum visualization is about twice as long.

4. No clinical evidence of immediate pain, residual soreness, or subsequent damage to tissue has been attributable to the concentrated solution of diodrast.

5. Satisfactory excretory urography demands adequate preparation of the patient, excellent roentgenographic technic, and correlation of roentgenography with renal function and the clinical problem.

6. The extra-vascular injection of undiluted neo-iopax, hippuran, and skioldan seems contra-indicated on the basis of excessive concentration and large volume of solution, although we have had no clinical experience with these other materials.

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# PSEUDO-GASTRODUODENAL FISTULA

WITH REPORT OF ONE CASE<sup>1</sup>

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GASTRODUODENAL fistula as a complication of gastric ulcer is rare. Monroe (12), in 1927, in a summary of the literature on fistula as a complication of gastric ulcer, found ten cases and added one of his own. Of these only two, his own and that of Casellas (2), had been recognized by roentgenology. Löw-Beer (8) refers to 12 cases, eight of which were on an ulcer basis, and adds one of his own. These 12 cases include six of those summarized by Monroe. Of the cases reviewed by Monroe and Löw-Beer, five, those of Casellas, Monroe, Berg, Haudek, and Löw-Beer, were recognized by roentgen examination.

Melchart (10) reports two cases and points out that these, and some of those reported in the literature, although having a roentgen appearance of gastroduodenal fistula, are not true fistulae, but are due to contraction of the lesser curvature drawing the pylorus upward and to the left.

We have found reports of 11 cases, in addition to those mentioned by Monroe and Löw-Beer, which have been recognized by roentgen examination, making a total of 16 cases of true or pseudo-gastroduodenal fistula recognized by roentgenology. To these we add one case of our own.

## PATHOLOGY

This condition is essentially a complication of chronic gastric ulcer. The pathologic process involved is discussed by Schinz (14), Löw-Beer (8), and Melchart (10). Chronic gastric ulcer is characterized by a higher degree of peri-ulcerus infiltration and connective tissue proliferation than is acute ulcer. In long-standing cases there

may be diffuse serositis and infiltration of the longitudinal muscle fibers of the lesser curvature. Contraction of the resulting cicatricial tissue produces shortening of the lesser curvature. In the original fish-hook stomach, involvement of the hepatogastric ligament draws the pylorus and cap upward to the right; involvement of the hepato-duodenal ligament draws it up to the proximity of the ulcer. Further shortening of the lesser curvature and involvement of the circular muscle layer produces a bilocular stomach. The pylorus being drawn to the niche, the lower pole of the stomach has a tobacco-pouch appearance. The duodenum is elongated and drawn to the left, and the meal apparently passes into the duodenum through a fistula from the niche. Inability to find the pylorus in its usual location will suggest the true nature of the process.

A true fistula may form when the cap is drawn into the proximity of the niche but not actually into it, but with the cap and pylorus in such close proximity to the ulcer it may be impossible to demonstrate a fistula, even though it is present. This was true in Lüdin's case (9), where two openings, one the normal pylorus, the other a fistula between the ulcer and the cap, separated by a narrow bridge of tissue, were found at operation. The fixation of the pre-pyloric portion of the stomach high on the lesser curvature was recognized by roentgen examination, but the perforation was not.

In the long fish-hook stomach, where the cap lies normally in fairly close proximity to the lesser curvature, a penetrating ulcer might perforate into the superior duodenum, as suggested by Thierfelder (15), without marked shortening of the lesser curvature. This would be more apt to occur with simultaneous ulcers of the stom-

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ach and duodenum. Berg's case (1), in which the meal left the stomach through the pylorus and then ran back from the duodenum into the stomach, through a fistula, may have been one of this type.

Thierfelder's (15) case was diagnosed by necropsy and was similar to Lüdin's (9). The pylorus was high on the lesser curvature and Thierfelder suggested that the rarity of the condition might be accounted for by constitutional types. He apparently assumed that the fish-hook type of stomach was rare. His report was made almost thirty years before the roentgen ray made possible the study of the position of the normal stomach during life, and this assumption may have been in accord with the accepted anatomic belief of that time.

In the cases we have reviewed, the duration of ulcer symptoms has been given in eight, and varies from three years (3) to thirty-seven (10) and thirty-eight years (9). A definite ulcer of the lesser curvature had been demonstrated on roentgen examination in five cases, from one month (5) to eight years (10) before the fistulous appearance was found.

#### ROENTGEN FINDINGS

For the diagnosis of true gastroduodenal fistula it is necessary to demonstrate a passage through the normal pylorus and a separate passage through the fistula, or a retrograde filling of the duodenum proximal to the fistulous opening. On the other hand, inability to demonstrate the pylorus and cap, apart from the fistula, does not necessarily refute the presence of the latter, as in neither Moiroud's case (11) nor in that of Lüdin (9) could it be found, although a fistula was found in each case, at autopsy in the former, and at operation in the latter. In such cases a fistula cannot be proved to exist by roentgen examination alone.

In pseudo-gastroduodenal fistula the opaque meal passes directly into the duodenum high on the lesser curvature and no pyloric opening can be found lower in the stomach. In addition, there is usually a bilocular or tobacco-pouch stomach with

retention in the lower pole. In three of the 11 cases found in the literature (3, 7, and 13), bilocular stomach is not mentioned; in two (7 and 8), retention is not mentioned. In Monroe's case (12) there was no retention at the time of the last examination, probably because of the gastro-jejunosomy opening in the lower pouch. With these exceptions, bilocular stomach and retention were present in every case.

In addition, there may be increased or decreased peristalsis, increased secretion, gastrosplasm, atony, or dilatation. Frequently the lower pole of the stomach empties only when lifted upward. Rigidity and shortening of the lesser curvature are always present, and the entire stomach is usually to the left of the mid-line.

#### SUMMARY OF REPORTED CASES

Moiroud (11) reports a case in which a fistulous communication between the stomach and duodenum at the duodeno-jejunal junction was found at autopsy. On roentgen examination the meal was observed to appear in the jejunum without passing through the pylorus and duodenum. In Lüdin's case (9) the stomach was vertical and bilocular, the barium ran downward to the right from the lesser curvature above the lower pole. At operation, the pyloric portion was found to be a dilated pouch. The anterior face of the lesser curvature was fixed by scars to the duodenum, with marked shortening of the lesser curvature. The pylorus communicated with the duodenum through two openings, separated by a narrow bridge of tissue: the lower of these openings was the pylorus.

In three cases, those of Berg (1), Haudek (6), and Casellas (2), the diagnosis was made by roentgen examination, unconfirmed by operative or necropsy findings. Nevertheless, a diagnosis of true fistula is justified in each case. In Berg's case the meal was expressed from a dilated lower pouch through the pylorus but ran back into the stomach through a fistula from a penetrating ulcer on the lesser curvature. The appearance of the stomach in his

illustration is quite similar to that of pseudo-fistula, except that the pylorus can be distinguished as separate from the fistula. Haudek's case, reported by Löw-Beer, shows a fistulous tract from the middle of the lesser curvature to the duodenal cap. At the same time the pylorus is seen. There is no noticeable shortening of the lesser curvature. Casellas reports a case in which two openings from the stomach to the small intestine could be demonstrated, the pylorus in normal position, and an opening from the upper pouch of the stomach into the jejunum or terminal duodenum.

No other reports of true gastroduodenal fistula, proved by either operation or autopsy, have been found, although 11 other cases which have the roentgen appearance of gastroduodenal fistula have been reported. In these cases it has been proved, by autopsy in one case, and by operation in five others, that no fistula was present. In two others (3 and 12) an operation was performed before the roentgen diagnosis, and in each case the surgeon made a diagnosis of inoperable gastric carcinoma, since disproved in each instance.

Melchart (10) reports a case which came to autopsy in which a large ulcer scar of the pars pylorus extended from the anterior to the posterior surface of the lesser curvature. There was kinking of the lesser curvature. The cardia and the pylorus were drawn toward each other into the scar. There was no fistula. Roentgen examination revealed a bilocular stomach from which the meal entered the duodenum through the middle of the lesser curvature. The lower pole was still filled at 24 hours. Similar roentgenological findings were present in six cases (4, 7, 12, 13, and 14, 2 cases) in which no fistula was found at operation, but all showed serositis and shortening of the lesser curvature with high displacement of the duodenal bulb. The length of the lesser curvature was stated to be 4 or 5 cm. in one case (4), and the breadth of three fingers in another (13).

Curiously enough, in the two cases (3 and 14) in which laparotomy was per-

formed previous to the roentgen examination at which the diagnosis of fistula was made, the operating surgeon made the diagnosis of inoperable gastric carcinoma because of the indurated lesser curvature and indurated masses in the lesser omentum or liver. In Monroe's case (12) a later roentgen diagnosis of gastric ulcer was made. At this time the stomach was atonic and divided into two pouches by an incisura on the greater curvature. On the lesser curvature, opposite the incisura, was a projection near which the barium was seen to pass apparently into the small intestine. The sphincter duodenum and the antrum were not seen. There was a 24-hour retention. At operation, a mass due to induration of the lesser curvature and fading away in all directions was found. The pylorus was drawn up and to the left to the under surface of the left lobe of the liver to which the entire lesser curvature was adherent. No carcinoma or metastasis was found and no mention is made of a fistula. An ulcer of the lesser curvature, which had perforated but which was prevented from extravasation by adhesions, was found. A posterior gastro-enterostomy opening was made. Roentgen examination seven years later revealed much the same findings, although the stomach was now hypertonic and there was a gastro-enterostomy opening in the lower pouch which was functioning—thus there was no retention at six hours. The duodenal cap could not be identified. At this time the impression was: "Gastric ulcer, hour-glass stomach, gastroduodenostomy (probably spontaneous), gastrojejunosomy." In view of the resemblance of this case to those reported since that time, in which no fistula was found, as well as the fact that the differences in appearance between the first and second examinations can be explained by the gastro-enterostomy, it seems probable that this is a case of pseudo-fistula, as no fistula apart from the pylorus was demonstrated. As surgery was not indicated at the time of the last examination, no operative check on this finding was possible.

In Cato's case (3) there was also a roentgen diagnosis of gastric ulcer before operation, and at 17 months after the operation the crater had increased in size and the pylorus and pyloric segment of the duodenum were drawn up on the lesser curvature adjacent to the ulcer, so that the second portion of the duodenum occupied the normal position of the cap. Five months later, on another roentgen examination, the meal passed through the ulcer directly into the first portion of the duodenum. No meal could be forced through the pylorus. There was a 40 per cent, five-hour residue. Cato reported this as a fistula, but as the pylorus could not be seen it was probably drawn into the ulcer, near which it was previously found. In favor of the diagnosis of fistula was the marked clinical improvement of the patient. This case was complicated by the presence of syphilis, and it is impossible to evaluate correctly the effect of antisyphilitic treatment on the clinical improvement or the rôle of the disease in the ulceration and induration of the stomach.

Löw-Beer (8) reports a case not confirmed by operation or autopsy. Gastroscopic examination showed the mucous folds to converge into the niche of a caloused ulcer with a definite rim. Regurgitation of the duodenal contents into the stomach was observed, and the thickened converging folds were seen to converge abruptly into the mucous membrane of the superior duodenum. On roentgen examination similar mucosal markings were seen. The mucosal relief of the pyloric portion was separated from that of the body by a narrow shadow which Löw-Beer thought to result from a fusion of the lesser curvature and the pyloric segment, with a fistula between the stomach and duodenum above it. However, since the pylorus or cap could not be demonstrated, it is probable, as Melchart (10) suggests, that this septum is the result of scar tissue below the displaced pylorus, the entire contracted lesser curvature being above the latter. The roentgen examination in this case, the second case of Melchart (10),

and in that of Hautefeuille (5), which were proved by neither operation nor autopsy, was characteristic of pseudo-gastroduodenal fistula.

#### CASE REPORT

J. N., white male, aged 40, entered the hospital Nov. 12, 1936, for the treatment of gastric ulcer. He gave a history of stomach pains with vomiting, while in the Army in 1918. In 1923, after a roentgen examination, he was told he had chronic appendicitis and a "dropped stomach"; in 1924 a gastric ulcer was found. He had hematemesis in 1923, and again in 1928. At the time of the latter hemorrhage he was hospitalized for one month, and was put on a 21-day milk and cream diet.

A year later he had a sudden pain while eating spare-ribs and sauerkraut. He had to be helped to bed. His physician was called and told him that his ulcer had ruptured and that an operation was necessary. He refused operation or hospitalization and remained in bed for two weeks. After a short ambulant period he re-entered the hospital for three weeks and received the same treatment as on his previous admission. At this time, Aug. 22, 1929, roentgen examination showed a large, hypotonic, fish-hook stomach. There was an hour-glass deformity with a niche opposite this on the posterior wall of the lesser curvature. The duodenum was fixed but not tender. There appeared to be dilatation of the third portion of the duodenum and some delay in this region. There was a 40 per cent, six-hour residue, and a 20 per cent residue at 24 hours.

Since that time he has been hospitalized several times. In July, 1930, a roentgen examination showed a filling defect on the lesser curvature, with marked spasm. Gastric carcinoma was suspected. In December, 1930, a roentgen examination by a third physician showed the stomach mostly to the left of the spine. At this time the findings were apparently the same as in July, but additional statements were made that the pylorus and cap were not visual-

ized and that there was a large five-hour residue.

The patient first entered this hospital Oct. 19, 1934. The report of the roentgen examination of the stomach at that time indicated findings similar to those described above. The duodenum was described in more detail than previously: "It was with some difficulty that the bulb could be visualized; it appeared to lie posterior to the pars pylorica and did not fill completely at any time; meal passed rapidly through it and outlined the second, third, and fourth portions; the second portion gave the impression of elongation and took its course well over into the left half of the abdomen." The impression of the roentgenologist making this examination was that the findings were probably due to gastric neoplasm with possible encroachment upon the duodenum. He stated: "The process seems too extensive to be accounted for by marked scar formation or perigastric adhesions attendant upon gastric ulcer." Though this statement seems logical, it is to be remembered that two cases are reported in the literature in which on examination at laparotomy the process was so extensive that a diagnosis of inoperable carcinoma was made, and others with marked perigastric adhesions are reported.

At this time the patient weighed 147 pounds and was 72 inches in height. His red blood cell count was 4,980,000, his white cell count 10,000. The hemoglobin was 88 per cent; the Wassermann reaction was negative. Test meal showed total acidity 54, free HCl 40. No blood was found in the gastric contents. A final diagnosis of peptic ulcer was made. Operation was advised but refused. The patient was put on a modified Sippy diet and left the hospital 28 days after admission, much improved, and showing a gain of 15 pounds in weight.

The patient was re-admitted to this hospital Nov. 12, 1936. His pains were now most severe when the stomach was empty. He had no other complaint; did not vomit; had lost no weight. During the interval since his previous admission

he had been hospitalized elsewhere and given a preparation of histidine monohydrochloride, with considerable relief. Nothing of significance was found on physical examination or on routine laboratory ex-



Fig. 1. Illustrating the course of the duodenum from the mid-portion of the lesser curvature, and the lower pouch of the stomach in which the pylorus cannot be found.

aminations. Nothing was obtained from the stomach on passage of a Rehfuess tube. Although there was no anemia, occult blood was found in the feces on two occasions.

On roentgen examination the esophagus showed no abnormality. On reaching the pars media of the stomach, the barium stopped temporarily. At this point there was a large ulcer niche on the lesser curvature. Some of the meal then trickled into the lower portion of the stomach, which was dilated and formed a pouch. A deep incisura on the greater curvature produced a bilocular stomach. The entire stomach was to the left of the mid-line. A portion of the meal passed through the ulcer niche into the small intestine. At this time the impression received was that the meal passed into the duodenum near the duo-

deno-jejunal junction through a spontaneous gastro-enterostomy, although no retrograde filling of the duodenum was accomplished. The pylorus and cap were not distinguished, all the meal leaving the stomach through the opening on the lesser curvature. There was a 10 per cent, six-hour residue in the lower pouch, and a small amount of barium remained in it at 24 hours.

As the patient did not desire an operation, and showed improvement under medical treatment, he left the hospital Dec. 17, 1936, and no operative check on the condition was obtained.

A roentgen examination was made in the out-patient department Aug. 3, 1937. No change in the stomach was seen. The meal passed from the upper pouch into the lower as at the previous examination. That passing into the small intestine could be seen to pass into the superior duodenum, which was directed obliquely downward and to the right (Fig. 1). The descending duodenum was short and somewhat dilated, but there was no stasis in this area. The barium then curved upward and to the left to the jejunum behind the stomach. The pylorus could not be visualized on the lower portion. None of the barium could be seen to leave this portion, except that which could be expressed upward and through the niche. There was a 15 per cent, six-hour residue in the lower pouch, and a small amount was still present at 24 hours.

#### SUMMARY

A case of extensive periserositis of the gastric lesser curvature giving a roentgen appearance of gastroduodenal fistula is reported. Reports of 11 similar cases have been found in the literature, in eight of which no fistula was found at operation or autopsy. Reports of five cases of true gastroduodenal fistula, together with roentgenological findings, have been found.

Since the marked induration which is present may lead to a diagnosis of carcinoma, even at operation, it is essential that the roentgenologist familiarize himself with the history of the case. This condition occurs in patients with gastric symptoms of long standing, usually with a definite, previous diagnosis of gastric ulcer. If the possibility of this condition is kept in mind, and the patient's history taken into consideration, the correct diagnosis will be apparent.

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# POSTMORTEM FINDINGS AND RADIO-ACTIVITY DETERMINATIONS FIVE YEARS AFTER INJECTION OF THOROTRAST

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RECENTLY there has been considerable discussion as to whether or not thorotrast should be used for visualization in radiography of the liver and spleen. Thorotrast contains "25 per cent by volume of thorium dioxide (19 per cent to 20 per cent by weight), about the same amount of protective colloid, said to be of a carbohydrate nature and further defined as a dextrin preparation. It contains as a preservative 0.15 per cent of methyl p-hydroxy benzoate" (1).

## REPORT OF CASE

The patient, female, white, by occupation housewife, aged 73, was admitted to the Montefiore Hospital on May 18, 1937, with complaints of weakness, vertigo, palpitation, shortness of breath, a choking sensation in the chest, insomnia, anorexia, and nervousness. In 1932 she had been admitted to another institution for increasing weakness and loss of weight of five months' duration, together with anorexia, palpitation, and dyspnea on exertion. Five months before, she had had a three-day period of chills, fever, and malaise. On physical examination at that time, the spleen was palpable and the liver questionably enlarged. Seventy-five c.c. of thorotrast were injected intravenously in equally divided doses on June 16, 17, and 18, 1932. Hepatolienography showed slight enlargement of the spleen. Various liver function tests showed no abnormalities.

The patient was transferred to the Montefiore Hospital, where she was observed for ten weeks. Her liver enlargement disappeared, while the splenomegaly remained. She was in auricular fibrillation throughout the period of observation. She was considered to have atrophic cirrhosis

with splenomegaly. The patient was discharged on a maintenance dose of digitalis and was not closely followed for five years.

On May 18, 1937, she was re-admitted with the complaints mentioned above.

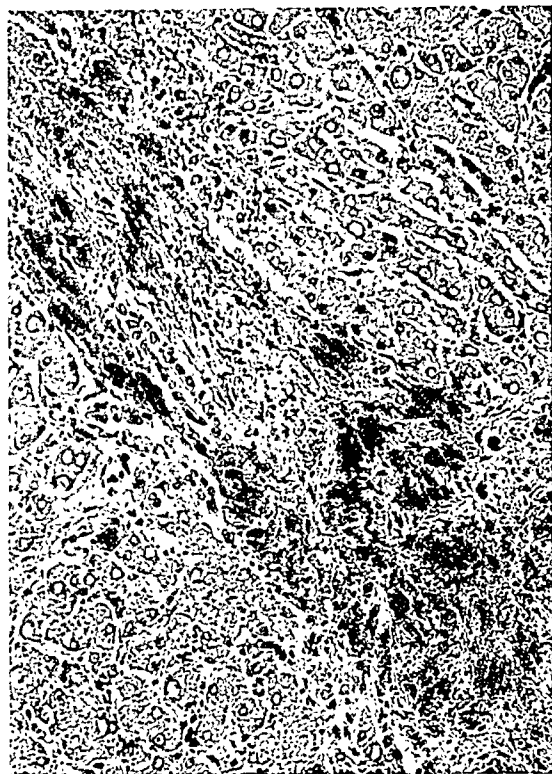


Fig. 1. Section of the liver showing portal fibrosis and collections of thorium in the portal canals. Occasional reticulo-endothelial cells in the sinusoids contain thorium. Hematoxylin and eosin stain ( $\times 240$ ).

The liver was barely palpable and the spleen was moderately enlarged. Examination of the heart, clinically and electrocardiographically, disclosed auricular fibrillation. The liver function tests were normal. There was a moderate secondary anemia. The total plasma proteins were 7.3 gm. per cent, with albumin of 2.4 and globulin of

4.9. The Wassermann and Kahn tests, as in the past on each hospital admission, were negative. On June 9, 1937, three weeks after admission, both lower extremities suddenly became very dusky, no

ened. The organ was indurated and heavy, but not firm. The pulp was red and stippled with miliary yellowish deposits. A healed infarct was present in the upper pole. The lymph nodes showed no gross

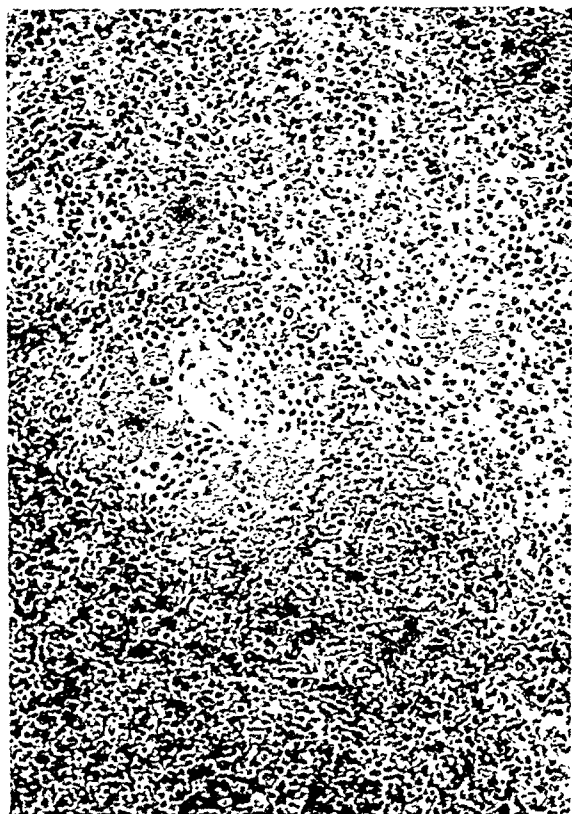


Fig. 2-A.

Fig. 2-A. Section of the spleen showing cells laden with thorium in the pulp and in the peri-arteriolar tissue. Hematoxylin and eosin stain ( $\times 240$ ).

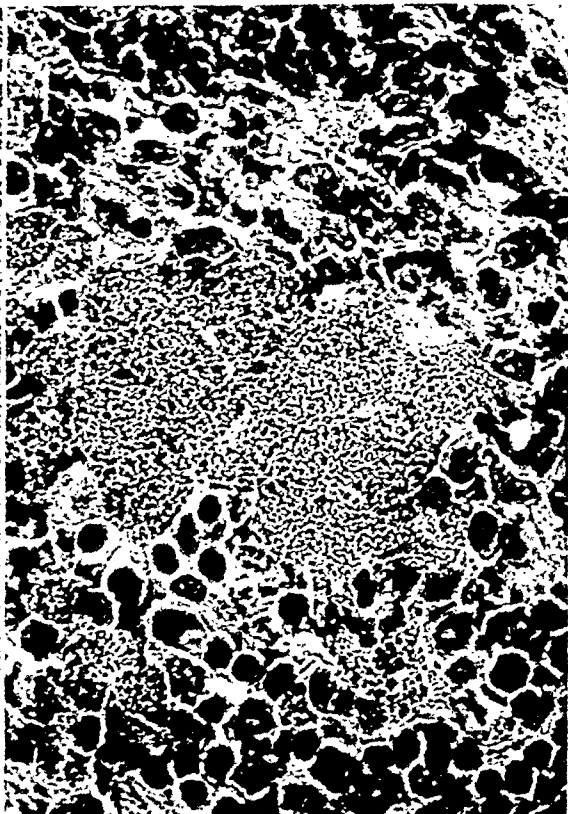


Fig. 2-B.

Fig. 2-B. Section of the spleen showing reticulo-endothelial cells in the pulp. They are laden with thorium and are markedly swollen. Hematoxylin and eosin stain ( $\times 960$ ).

pulses could be felt in them, and death ensued in a few hours.

At necropsy, the significant changes were found in the liver, spleen, lymph nodes, mediastinum, and femoral arteries. The liver weighed 1,150 grams, measured  $21 \times 14 \times 6$  cm., and was firm in consistency. It showed irregular surface depressions in a few areas. On section, the lobules were grayish and indistinctly delineated. There was a retracted, yellowish, streaked, fibrous network throughout. The spleen weighed 180 grams and measured  $12 \times 7 \times 3$  cm. The capsule was irregularly thick-

changes. There was a large cystic mass, six to seven centimeters in diameter, in the anterior superior mediastinum. It had a thick fibrous wall and was filled with brownish, jelly-like material. It was interpreted as an old hemorrhage. Thrombosis of both femoral arteries was present.

Hematoxylin and eosin preparations of the liver (Fig. 1) showed large masses of a thorium compound in the form of grayish-green granules. These were found largely in the portal spaces, where some of them seemed to lie free in the fibrous tissue, which was slightly increased. Other

masses of thorium compound were found in phagocytes in the portal spaces. Some of the sinusoids appeared to be occluded by large masses of the material. These lay in swollen Kupffer cells. Some of the portal canals containing this substance showed an associated infiltration with a few polymorphonuclear leukocytes. The polyhedral cells were not markedly diseased but did show a moderate amount of parenchymatous degeneration.

Sections of the spleen (Figs. 2-A and 2-B) showed large collections of the same type of granular material. These were massed in and about the splenic corpuscles (which were atrophic), near the fibrous trabeculae, and near the sheathed arterioles. In these locations, the substance lay in large phagocytic reticulo-endothelial cells. In addition, thorium-laden reticulo-endothelial cells were scattered in the pulp. There was a moderate increase in the fibrous tissue. The infarct at the upper pole consisted of partially hyalinized collagenous scar tissue, among the fibers of which many masses of thorium granules were seen. These seemed to be extracellular. The large amount seen here was probably due to condensation with contraction of the scar.

A lymph node (Fig. 3) from the region of the gall-bladder bed contained large masses of thorium, both in germinal centers and in the reticulum throughout the lymphoid tissue. In hematoxylin and eosin preparations, the first impression was that of amyloidosis. There was marked fibrosis. The lymph nodes in the mediastinum contained no recognizable thorium, nor were they fibrotic. The bone marrow showed neither thorium deposits nor fibrosis. All of the cells containing the thorium compound showed a peculiar opacity of the cytoplasm. The cystic mass in the mediastinum appeared, on microscopic examination, to be an organizing hematoma.

#### MEASUREMENTS OF RADIO-ACTIVITY

Soon after the death of the patient on June 9, 1937, 131 grams of liver were ashed to 2.508 grams and measured on a

Geiger counter. Insufficient precautions were taken to eliminate the beta rays and the standardizing source of radium was too strong. These data were therefore discarded. In December, the same ash was

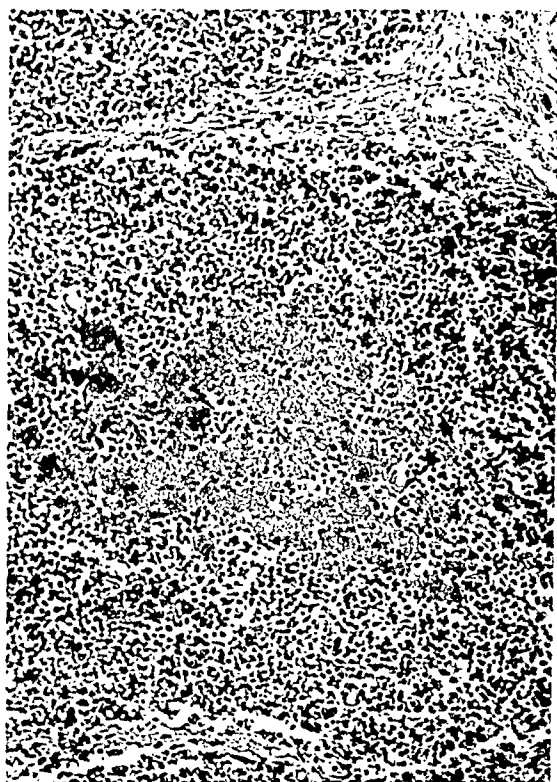


Fig. 3. Section of a perihepatic lymph node showing large numbers of reticulum cells, each enlarged and filled with thorium. Hematoxylin and eosin stain ( $\times 240$ ).

remeasured on another Geiger counter using a 2.5 mm. lead filter, but the counts were too few above the background. Three hundred and eighty-six grams of the liver, which had been kept for six months in 10 per cent neutral formalin, were ashed to a weight of 6.957 grams. This amount was sufficient to give good measurements.

A diagrammatic sketch of the set-up is given in Figure 4.

It has been reported (2) that formalin in which liver and spleen were preserved was not radio-active. A sealed bottle containing 90 c.c. of the formalin was placed about 6 centimeters from the center of the chamber and no increase in counts above the background was found. It was

assumed, therefore, that the radio-active material in the liver had remained undissolved.

A brief description of the method of measurement may be of value. The ash

accurate standardization work with such weak sources, the values based on this standard must not be judged to be of greater accuracy. The 12 c.c. vial of thorotrast was at least one year old.

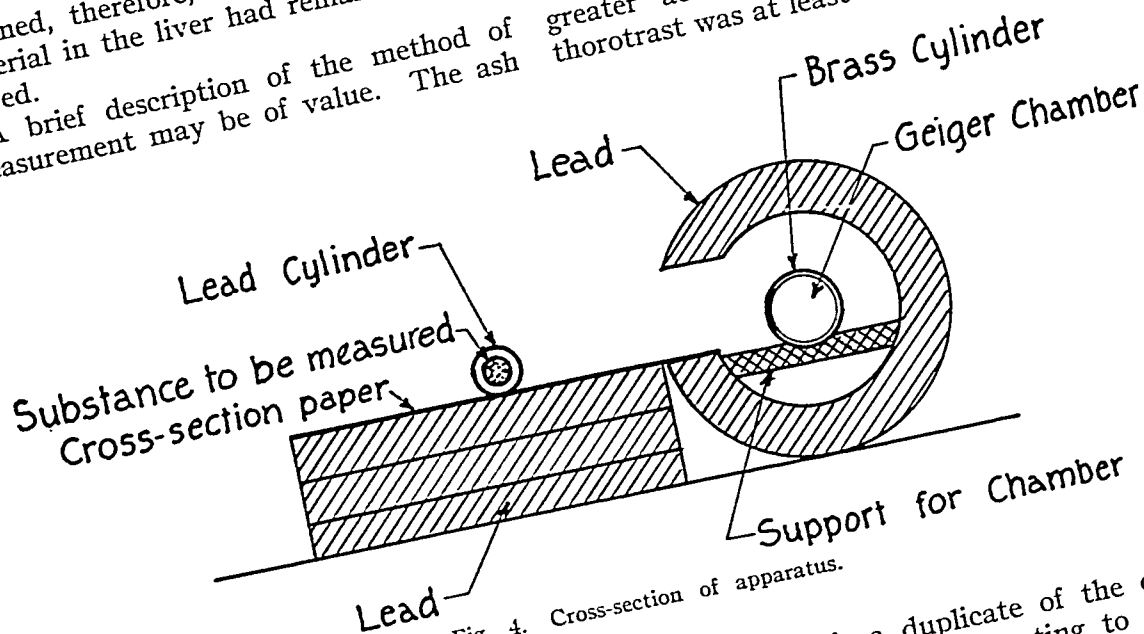


Fig. 4. Cross-section of apparatus.

was contained in a glass bottle, the walls of which were about two millimeters thick. This bottle just fitted into a cylinder of lead 2.5 mm. thick, which was placed on centimeter graph paper, in order to aid in centering, at a distance of 10 centimeters from the center of the chamber. The bottle of ash could be removed and replaced by a 12 c.c. bottle of thorotrast or a gold seed containing radon. A brass cylinder, 0.8 mm. thick, surrounded the counter chamber to increase its sensitivity. This brass can also be considered as additional filter to the 2.5 mm. of lead and glass in removing the beta rays. The counts are due almost entirely to gamma rays.

A gold radon seed of 0.3 mm. gold filtration was used as the standardizing source. The seed was sealed into a glass vial in an attempt to prevent contamination of the counter. The radon seed was calibrated by the radium company when its strength was 0.3 millicurie. However, this was much too strong a source for the counter and it was used after it had decayed to 0.04 millicurie. Since the original method of measurement is not intended for

Table I is a duplicate of the original data. It may be interesting to note in Table I that the lead cylinder increases the background from 17.4 to 18.6 and when it is put up closer, to 22 counts. Lead is generally slightly contaminated with radioactive material.

The results in Table II show that there still remained in the liver, five years after the injection of 75 c.c. of thorotrast, approximately 27 per cent of the original gamma-ray activity of the thorotrast. Using Taft's (2) results, which state that 75 c.c. of thorotrast are equivalent in gamma rays to 1.37 microgram of radium, this liver would still contain a gamma ray equivalent to 0.37 microgram of radium. According to the figures in Table I, this liver contains approximately 0.3 microgram. Although, as previously pointed out, the absolute value of the gamma-ray activity in the thorotrast has no greater accuracy than the measurement of the standard (1), it is of real significance to note that about 27 per cent of the thorotrast gamma-ray activity was present after five years.

In making exact measurements, one

should (a) make certain that the original radium or radon source is accurately standardized and is or has become sufficiently weak; (b) make certain that the equivalent filtration for the standardizing source, the

Taft (3) has found 51 per cent of the original dose in the ash of a liver a little over a month after the injection. According to the above measurements, there is 27 per cent five years after injection.

TABLE I.—MEASUREMENTS OF LIVER ASH, THOROTRAST, AND RADON ON GEIGER COUNTER

Conditions	Distance	Readings on Counter		Count	Time	Counts per min.	Back-ground per min.	Corrected Count min. per
		From	To					
Brass cylinder on chamber		18:0	19:27	174	10 min.	17.4	17.4	
2.5 mm. thick lead cylinder at	10 cm.	3:0	12:19	1,118	60 min.	18.6	18.6	
12 c.c. thorotrast vial inside of Pb cylinder	10 cm.	14:0	17:2	364	10 min.	36.4	18.6	17.8
Liver ash in Pb cylinder	10 cm.	19:0	21:18	276	10 min.	27.6	18.6	9.0
Liver ash in Pb cylinder	10 cm.	0:0	7:15	870	30 min.	29.0	18.6	10.4
12 c.c. thorotrast vial inside Pb cylinder	10 cm.	8:0	11:1	362	10 min.	36.2	18.6	17.6
Pb cylinder close to chamber	x cm. close to counter	20:0	21:42	204	10 min.	20.4	20.4	
12 c.c. thorotrast in Pb cylinder	x cm. close to counter	12:0	18:1	722	10 min.	72.2	20.4	51.8
Liver ash in Pb cylinder	x cm. close to counter	22:0	26:0	480	10 min.	48.0	20.4	27.6
12 c.c. thorotrast in Pb cylinder	x cm. close to counter	26:0	2:2	724	10 min.	72.4	20.4	52.0
Pb cylinder	x cm. close to counter	8:0	9:50	220	10 min.	22.0	22.0	
Liver ash in Pb cylinder	x cm. close to counter	3:0	7:22	524	10 min.	52.4	22.0	30.4
Liver ash in Pb cylinder	x cm. close to counter	10:0	14:16	512	10 min.	51.2	22.0	29.2
Gold radon seed 0.0414 mc. in Pb cylinder	20 cm.	20:0	30 + 5:37	5,474	5 min.	1,095	18.6	1,076
Gold radon seed 0.0414 mc. in Pb cylinder	40 cm.	22:0	5:43	1646	5 min.	329	18.6	310

liquid thorotrast, and the ashed liver is the same. One suggestion offered by Dr. Steigmann, of Columbia University, is to inject 75 c.c. of thorotrast into a weight of liver equal to that under investigation, then ash this liver exactly as the latter, and compare equal weights of ash.

## DISCUSSION

The explanation of the presence of fibrosis in the liver, spleen, and hepatic lymph node in this case is a complex question. It may very well be that these changes were present before the thorotrast was injected. However, if the pa-

tient were suffering from cirrhosis of the liver at that time (1932), it is unlikely that the process would not have advanced

present was sufficient to induce the fibrotic changes seen in the liver, spleen, and lymph nodes.

TABLE II.—CALCULATIONS FROM TABLE I

	Distance in cm.	Av. count per min.	Percentage	Equivalent γ-ray activity in mgm. radium
(1) 12 c.c. thorotrast	10	17.7		
(2) 386 gm. liver ashed	10	10.05		
(3) Percentage of counts of 12 c.c. thorotrast in ash	10		57	
(4) 12 c.c. thorotrast	Up close	51.9		
(5) 386 gm. liver ashed		29.1		
(6) Percentage of counts of 12 c.c. thorotrast in ash			56	
(7) Average percentage of counts of 12 c.c. thorotrast in ash			56.5	
(8) Percentage of γ-ray activity of 75 c.c. thorotrast found in 1,150 gm. liver			27	
(9) 0.04 mc. radon gold implant	10	4,304 calc	ulated from	counts at 20 cm.
(10) 0.04 mc. radon gold implant	10	4,960 calc	ulated from	counts at 40 cm.
(11) 0.04 mc. radon gold implant	10	1		$9 \times 10^{-3}$
(12) 75 c.c. thorotrast calculated from counts in 12 c.c.	10	111		1
(13) 1,150 gm. liver calculated from No. 12				.27

farther than the stage at which it was at the time of death in 1937. On the other hand, there is experimental work, as well as clinical observations, which would lead one to believe that the presence of thorium in an organ injures the parenchyma and stimulates the formation of fibrous tissue (5, 6, 7, 8, 9, 10, and 11). Naegeli and Lauche (12) found that thorium, after its primary deposition in the liver, spleen, and bone marrow, gradually moves to the regional lymph nodes of these organs; after three years the amount of thorium in the nodes may be large enough to cause necrosis. The amount of thorium seen in one of the hepatic lymph nodes in this case was greater than that seen in either the liver or the spleen.

In the light of these reports and the above findings, it seems likely that the changes noted at necropsy in this patient were due to the long-standing presence of thorium or its disintegration products and that the amount of radio-active substance

#### SUMMARY

1. A case is reported in which 75 c.c. of thorotrast were injected intravenously five years before death.

2. The gross and histological findings in the liver, spleen, and lymph nodes are described.

3. The ash of a liver preserved in 10 per cent neutral formalin for six months showed that the liver still retained 27 per cent of the gamma-ray activity of the 75 c.c. of thorotrast injected five years previous to death.

4. Ninety c.c. of the formalin in a sealed bottle did not show any radio-activity.

5. The approximate gamma-ray activity of the liver ash was 0.3 microgram of radium.

6. It is considered likely that the pathologic changes noted were caused by the presence of thorium in these organs for a long period of time, and not to antecedent disease.

We wish to express our gratitude to Professor J. R. Dunning, of Columbia University, for the use of the Geiger counters, and to Dr. E. J. Baumann, of the Laboratory Division of the Montefiore Hospital, for ashing the liver.

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# THE PRACTICAL AND EXPERIMENTAL ASPECTS OF THE ROENTGEN TREATMENT OF *BACILLUS WELCHII* (GAS GANGRENE) AND OTHER GAS-FORMING INFECTIONS<sup>1</sup>

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IN a period between August, 1928, and November, 1931, a little over three years, one of the present writers had the opportunity to treat eight cases of so-called gas gangrene infection with the x-ray, in conjunction with the other usual measures employed excepting amputation. In six cases the disease was confined to an extremity, and all of the patients recovered. Two cases involved the trunk, and both died. As reported (1) at the time it was thought that since all the extremity cases recovered, the trunk cases, being of much greater thickness, probably did not receive sufficient radiation to be considered as fair tests of the method, and it was recommended that in the future trunk cases be given more penetrating radiation.

Due to the rarity and seriousness of the disease, it was deemed justifiable to report the small number of cases observed up to that time, especially as the outcome in the extremity cases had been so strongly suggestive that the x-rays were of distinct benefit in this type of infection.

During the next four years some case reports (2, 3, 4, 5) appeared in the literature, and we continued to use the measure as the opportunity presented itself. In December, 1935, we presented it before (6) the Radiological Society of North America. Six months later we again presented the subject before the American Medical Association (7) in convention at Kansas City.

In preparation for this report we again sent out questionnaires and letters to everyone we thought might be able to add any case histories or other information to the problem. During the time covered by the first three reports, a period of about

eight years, we treated and collected data on 56 cases, or an average of seven cases per year. The last questionnaire, covering a period of less than one year, brought in data on 87 additional cases. From the increase in the number of patients treated in this short time it is apparent that at least one of the purposes of our first report has been accomplished, that is, that others try the method. It is also gratifying to be able to report that the results in other hands have been as good or even better than in our own.

In all, about 100 physicians scattered throughout the United States and Canada, reporting from some of the best institutions on this continent, have combined to contribute to this study, data on 143 cases.

At this point, we wish to take a moment to thank sincerely not only those who contributed case histories, but also those whose courteous and encouraging replies to our questionnaire were of greater help than we have words to express.

By means of this general co-operation, it has been possible to establish in a short period of nine years, what we think are some important facts bearing on the treatment of a relatively rare but very fulminating and crippling, if not fatal, type of infection. Before presenting any figures we might state that we have been very much impressed by what we are to present and lest we become over-enthusiastic and state as facts matters which should really be stated only as opinions, we wish you to judge the evidence from your most critical point of view.

## MORTALITY AND AMPUTATION

In support of our earlier statement that the co-operation of many clinicians has

<sup>1</sup> Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.



been worth while in quickly establishing the value of the x-ray in treating gas gangrene, we shall submit some facts and

four cases that received but one treatment per day. As indicated above, this is not adequate. The other two extremity cases

TABLE I

	Total Cases	Living	Dead	Percentage Dead	Extrem.	Trunk	Dead
Ordinary gas gangrene	123	113	10	8.1	105	18	6
Diabetic and arteriosclerotic gangrene	9	4	5	55.5			4
	132	117	15	11.3			

figures regarding mortality and amputations. From the results obtained in the cases presented to-day as compared with our past experiences and the literature on the subject, we are positive that by using the x-ray we lower mortality and lessen the necessity for therapeutic amputations.

Has mortality been lessened by the use of the x-ray?

We are certain that the mortality rate alone is no longer the standard of successful treatment of gas gangrene, and would suggest that a strict score on amputations be kept and the number of amputations as well as the deaths be included in reports concerning methods of treatment in this group of infections in the future.

A brief analysis of the ten patients who died shows four trunk cases: two of these died in the first series (it was thought that they did not receive the proper type of x-ray) and in one instance, postmortem showed that only part of the involved tissues had been irradiated. The third trunk death received one treatment each day for three days, and the fourth trunk case that died was radiated only over part of the diseased tissues. In the first report, as a result of the first two trunk deaths, it was stated that all of the involved tissue should receive radiation with adequate voltage to penetrate the part, and that a treatment should be given morning and evening through every port. A satisfactory dose is 100 r per port per treatment.

In the extremity deaths, there were

each received two treatments, one dying in 24 hours, the other dying in 18 hours after admission to the hospital. The clinician in each of these cases thought that death was due to injuries, but from the records submitted, we thought they showed evidences of severe toxemia and included them as gas gangrene deaths.

In the final analysis only the difficult cases die if they are x-rayed; that is, if treated with x-ray according to directions no case dies of gas gangrene that has not sufficient reason for death from causes other than the gas gangrene. When one considers the type of patient, either severely injured, senile, or debilitated, who develops gas gangrene, he will realize that in the primary disease, without the complication of gas gangrene, he has a variety of conditions, which in themselves will cause death in from 3 to 7 per cent of all cases.

The unfortunate individual who develops gas gangrene following a hypodermic injection may be an exception to those referred to as seriously injured, senile, etc. Unexplained pain, swelling, or fever following a hypodermic calls for an x-ray film for the presence of gas, and, if it is present, x-ray treatment is imperative.

#### AMPUTATIONS

In our first report we emphasized the facts that in no case was amputation necessary for any of the patients in that series; that no patient lost tissues because of therapeutic surgical procedures; that

any tissue removed was removed because of the severity of the injury. In our second and third presentations we were

TABLE II.—COMPARATIVE DEATH RATE IN CASES OF ORDINARY GAS GANGRENE, WITH AND WITHOUT AMPUTATION

(Has the use of the x-ray made amputation unnecessary?)

Total No. Extrem. Cases	Am- puta- tions	Dead	No Am- puta- tions	Dead	Per- cent- age Dead
105	33	3			9.1
			72	3	4.0
Necessary amp.	16	1			6.2
Therapeutic amp.	17	2			11.7

becoming quite strongly opposed to amputation as a therapeutic measure for gas gangrene. We are now absolutely opposed to it.

Table II shows a mortality of 4 per cent of cases in the non-amputation group as compared to 9.1 per cent mortality in the cases having amputation. This would seem to indicate that a patient can recover from gas gangrene without amputation; in fact, if there is no amputation and x-ray treatment is given, there is a better chance to recover than if there is an amputation. Some may say that it is unfair to figure the mortality in the amputation group against the non-amputation group, since many in the amputated group were so severely injured as to make amputation a necessity, hence they lost more blood, were in greater shock, and were, on the whole, poorer risks. Therefore, we checked the cases carefully and separated the cases in which amputation was done into two groups: (1) amputation of necessity, instances in which it was required by the character of the injury or done late in the disease after the acute phase of the gas gangrene had passed (removal of limb because of damaged tissue), and (2) a second group in which amputation was performed in the first few hours of the disease, not because of the severity of the

injury but for therapeutic purposes. The figures in Table II suggest that the deaths in the amputation group were not necessarily due to the severity of the injury since two of the three deaths were in the less severely injured group.

#### CONCERNING CORRECT DIAGNOSIS

The therapeutic amputation group is also very interesting because of its relation to the problem of correct diagnosis. A few doctors, mostly surgeons, have questioned the accuracy of the diagnosis of those cases that have been treated with the x-ray, but from the surgeon's point of view this group should be beyond question. Here are 17 cases with sufficient evidence of gas gangrene to warrant the surgeon's removal of an extremity, and surely no surgeon would remove an extremity for gas gangrene without satisfactory evidence that the patient had a gas-forming infection. But in this group of 17 cases, undoubtedly gas gangrene, only two died, or a mortality of 11.7 per cent, which some time ago would have been considered a very satisfactory record. It should be even more convincing when, as pointed out in previous reports, some of these patients still had gas in the tissues above the site of amputation but, regardless of that fact, recovered following x-ray treatment. There are x-ray films in the exhibit verifying this point. It would seem that these patients lost an extremity unnecessarily inasmuch as they still had the disease after the amputation. Their ultimate recovery can be attributed only to some cause other than amputation.

It is very pleasant to see the number of cases receiving x-ray treatment rapidly increasing, but to have many clinicians make a note on their records that "amputation was done because of the injury and not because of the gas gangrene" is most pleasant. Of these 33 amputations, 16 cases had such a notation, and, if we stop to consider, this means that only 17 out of 89 extremity cases were treated by the older method of immediate amputation on

diagnosis. It seems that this co-operation of many physicians in many States toward establishing the value of the x-ray in treating these cases has indeed been invaluable to these individuals who were permitted to keep their arms and legs.

No other series in the literature that we reviewed had such a small percentage of amputations. This 19.1 per cent should read "0 per cent" on all series in the near future.

Obviously no fixed law stating the time for the necessary amputations can be made.

One should not become over-enthusiastic regarding the use of the x-ray and neglect other measures. Surgery is commonly necessary in these cases and must be employed as indicated. Every case of gas gangrene is a serious clinical problem from the very start and no measure which might assist in the patient's recovery should be neglected.

#### DÉBRIDEMENT

There is no question but that a wound should be cleared of all foreign material and hopelessly isolated fragments of tissue as a result of severe injury. We do not intend to criticize the surgeon, but we are out to thoroughly discourage the surgeon who is inclined to unnecessarily mutilate or amputate. In the trunk cases there was no attempt at débridement and 14 out of 18 patients recovered, so one can recover without débridement.

In order to give the surgeon some support in a more conservative measure, such as the use of the x-ray, it will be necessary to establish the procedure in the literature, and, therefore, a plea is made for all to report their cases in detail through some source or other, preferably their state and special journals.

#### SERUM

The question of the use of serum is less important and more uncertain than any of the preceding aspects of the problem.

To start with, we may state that there are 18 cases so far reported which have had no gas bacillus serum either prophylactically

TABLE III

Total No. Extrem. Cases	Necessary Amp.	Bal. Extrem. Cases	Therapeutic Amp.	Percentage Ther. Amp.
105	16	89	17	19.1

TABLE IV

	No. Cases	Serum	No Serum	Dead	Percentage Dead
Ordinary gas gangrene, trunk and extremity	123	105	18	9	7.1
				1	5.5

or therapeutically. There has been one death in these 18 cases, a mortality of 5.5 per cent, so it does not seem that the use of serum is essential to recovery.

In Table IV the percentage dead is slightly lower among those who had no serum as compared to those who had serum, and there are sufficient numbers to be of some significance.

#### DIAGNOSIS AND CLASSIFICATION OF CASES

Gas gangrene as Graham (8) so clearly describes it, is a loosely applied term covering infections due to one or more of several anærobes. Other organisms are also found, so that the disease may not be by any means identical in detail in any two individuals.

In our reports up to this time, we have recognized only two types of cases, trunk and extremity, while now, as a result of our analysis of the additional data on hand, we are further dividing the disease into three different clinical phases: suspected cases, early cases, and late cases. In the suspected cases, the x-ray, when used, may be said to be used prophylactically. It would be used for that purpose in those patients who had an injury such as is commonly complicated by gas gangrene but before definite evidence of the disease is present. In the early and late

cases it would mean that the diagnosis had become definitely established, the early cases receiving x-ray treatment in the first 24 hours of the disease, while by the late cases are meant those in which the treatment is started after the first 24-hour period of active infection has elapsed.

#### TREATMENT—DOSAGE AND DANGERS

*The Suspected Case—Prophylaxis.*—In our animal experimentation work we thought we proved conclusively that the earlier treatment was started, the more easily the case was controlled and the sooner it subsided; and if treatment was started late it seemed to have much less effect.<sup>2</sup>



Many of the patients who received one or two doses of x-ray and recovered were treated in the earlier stages; the disease seemed to regress immediately, the patient's own resistance apparently coming in to control the situation from that time. The ability of the individual to respond and apparently assist himself in the battle following a dose or two of irradiation is a rather impressive clinical fact and, once he gets control of the situation, he does not seem to lose it.

In view of the above facts, what is there to prevent the more extensive use of the x-ray as a prophylactic measure against the development of gas gangrene? Many surgeons throughout the country are taking advantage of its simplicity and using it on all compound fractures. We sincerely

Fig. 1. Gas gangrene following hypodermic injection. H. G., male, aged 27, was given a hypodermic injection of boiled milk for a chronic Neisserian infection 24 hours before admission to the hospital. Within eight hours patient developed a large amount of swelling, with escape of gas at the site of injection. Patient was hospitalized, multiple puncture wounds were made throughout the thigh, and deep irrigations with potassium permanganate solution. He received a single treatment with mobile x-ray unit at 1:30 P.M. and was dead at 3:45 P.M. the same day.

This case is instructive from several angles. Any hypodermic injection followed by unusual symptoms, especially an unusual amount of pain, should have an x-ray film searching for gas in the deep tissues. If gas is present, x-ray treatment is imperative. This patient lived only two hours after the first x-ray treatment and less than 24 hours after receiving the hypodermic. Obviously, treatment was started too late for this type of infection, which is deep-seated and almost entirely sealed up, resulting in the rapid growth of organisms and complete absorption of toxin. The mobile unit used was probably inadequate. Heavier voltage through the thigh and trunk, including heart and large viscera, might have been more effective. Pasternack and Bengtson (9) show the damaging effects of the toxin on the viscera, and the quantity of toxin absorbed may be of more importance than the number of hours the infection has existed before treatment is started. This man was probably beyond help at the time of admission.

Since completing this article, four cases of gangrene following hypodermic injections have been reported to us, with but one recovery. This would indicate that this type of case must be treated early and thoroughly if any good is to be done. The earliest method of diagnosing the presence of a gas-forming infection following hypodermic injections is undoubtedly by the x-ray film. If gas is present, x-ray treatment should be given. If the gas is of accident no harm will be done; if due to infective origin good may be accomplished.

<sup>2</sup> The work of Pasternack and Bengtson (9) may explain the reason for this. They point out that vital organs, heart, kidneys, etc., are severely damaged early in the toxemia of *Vibrio* septic infection.

endorse this procedure, and in answer to any criticism as to its use for this purpose we have only to ask this question of the critic, "If you had a compound fracture, would you prefer the risk of gas gangrene to a few simple x-ray treatments which would in no way disturb or annoy you?" The answer is obvious.

A definite amount of x-ray to cover all cases will never be stated, as each case is a distinct clinical problem, but the x-ray is so effective that anyone with a working knowledge of radiation therapy should have no trouble in successfully treating a case if he is not compelled to start too late.

The thicker the part the higher the voltage and the more filtration is indicated, but since it is only necessary to treat over a period of three days, or at the longest five days, making the number of treatments vary from six to ten, no complications should arise from the use of 100 r per port per treatment, regardless of how many ports it may take, if the correct voltage and filtration are used. If treatment extends beyond the third day, unless new areas are being treated, 50 r per port might be sufficient. An increase in filter would also add to the protection of the patient.

#### FILTER

It should be understood, but apparently it is not, that no treatment was ever recommended with less than 0.5 mm. aluminum filter. Since 0.5 mm. aluminum filter is so small that many radiologists appear to consider it no filter at all, and have repeatedly treated cases without filtration, we wish again to make a plea for the use of filtration—at least 1 mm. of aluminum in all cases.

Many cases have recovered with the use of filtration up to 0.5 mm. of copper, and since recovery is possible with the use of filtration, and the absence of filtration may lead to serious complications, it seems only fair to these patients that some filter be used. The absence of filter during treatment can, we believe, be a legitimate source of criticism of the use of the x-ray in the treatment of gas gangrene. Only one

case so far has reported skin reaction from treatment, but we feel, from the dosage indicated on the record in one patient who died very early, that radiation necrosis would have been a possibility had the patient lived.

The question of the x-ray as a factor in preventing proper repair of the damaged tissue has been raised. So far, no com-



Fig. 2. Extension of gas gangrene following amputation. G. E. L., white male, aged 12, received injury to left forearm. Prophylactic and therapeutic serum administered. Amputation was done after diagnosis of gas infection was made. Amputation was below elbow. Gas infection extended up the arm into shoulder and adjacent thorax. X-ray therapy controlled this infection and the child made a quick recovery.

This was one of the early cases and it served to impress us with the fact that the amputation was unnecessary in that it had no therapeutic value. In this case a boy, aged 12, must go through the rest of his life without a wrist or hand. Again we wish to state that amputation of an extremity as a therapeutic measure for the treatment of gas-forming infections is an obsolete procedure. If amputation is necessary because of the severity of the injury, that is another matter, but as a therapeutic procedure for gas infection, it is poor practice.

plications have arisen in any of the cases to indicate that the amount of x-ray used is in any way detrimental to the normal

organisms with a relatively long space factor, that is, four or five days between treatments. More rapidly growing organisms

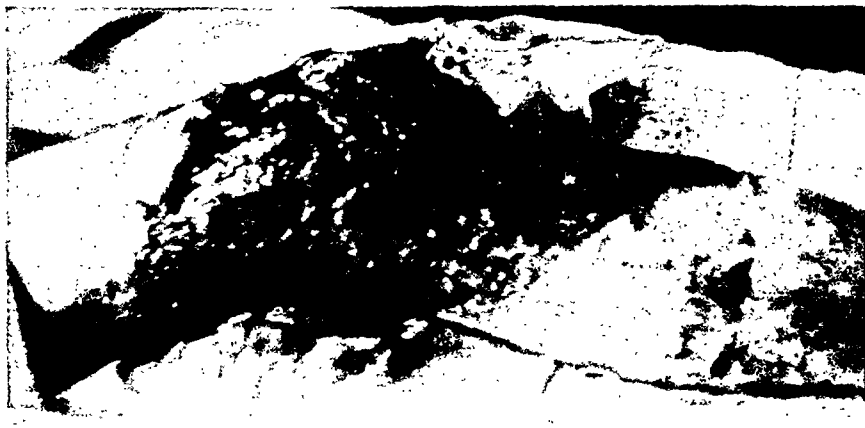


Fig. 3. Shows extent of injury. (See caption under Figure 5.)

and natural process of healing in any of the wounds treated. However, let us emphasize again that we have no reason to suspect that these tissues are immune from radiation necrosis following overdosage with x-ray, and we believe that in justice to the patient the ordinary precautions against radiation burns should be taken. Therefore, please use some filter and your best judgment. The use of filter tends to protect the patient against accidental over-radiation and, as far as we know, does not prevent the patient from receiving full benefit of the radiation given. This opinion has also the support of findings on experimental animals.

#### SPACE FACTOR

The reason for treating twice each day has been asked many times. The reason is only an opinion based on a clinical observation that the results were better when the space factor, or length of time between treatments, of the various infectious diseases, approximately coincided with the rate of growth on culture media or by clinical estimation of the etiologic organisms. For example, it has been our custom to treat blastomycosis, glandular tuberculosis, and many other slowly growing

such as the *Staphylococcus*, found in the ordinary boil or carbuncle, we treat with a somewhat shorter space factor, once each day; but in erysipelas, which is more fulminating in character, we have used a still shorter space factor which we thought more nearly approximated the growth cycle of the organism, and treated twice each day.

Since gas gangrene is undoubtedly as fulminating in character as erysipelas, it seemed to us that if any good was to come from the x-ray treatments, it should be from a series of treatments with a short space factor. The purpose in treating twice each day was to interrupt or in some way disturb the normal growth cycle of the organism if possible. Maybe this was accomplished, preventing the organism from producing its toxin, or it may be that the x-rays affect the toxin directly after it is produced, and by frequent x-ray treatments, prevent any great accumulation of the toxin in the tissues in a given time. Whether or not the x-ray has any anti-toxin action, or in what way it aids the tissue in absorbing, neutralizing, or otherwise detoxifying the infected tissues seems to us to be a very fundamental problem.

It might be well to make a plea that more

radiologists become interested in the x-ray treatment of infectious processes and by carefully kept records build up data, not only on the organisms which are locally destructive, such as the *Staphylococcus*, but also in that group of bacteria which are toxin-producers and amongst which are some of our most serious infectious diseases.

#### EARLY CASES

An early case has been defined as one in which the x-ray treatment is started be-

fore 24 hours have elapsed after the disease has become active. Of these cases, 100 per cent should recover.

#### LATE CASES

Late cases are those patients who receive no x-ray treatment during the first

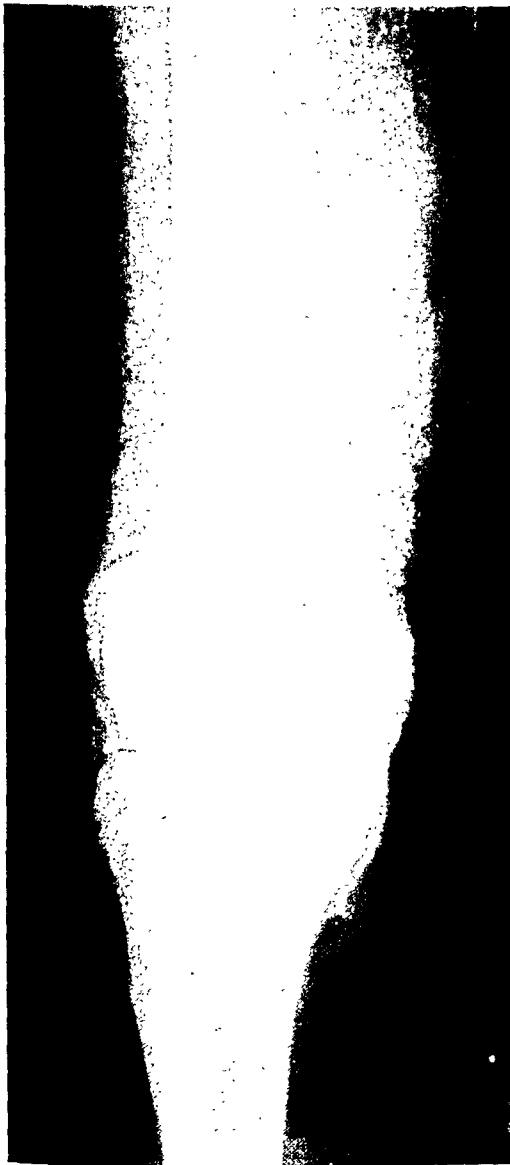


Fig. 4. Shows gas in the tissues. (See caption under Figure 5.)

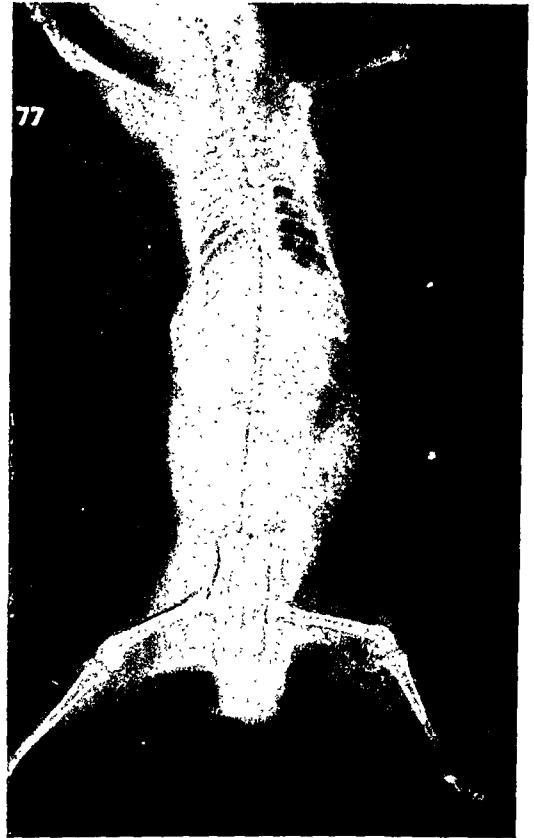


Fig. 5. M. S., white male, aged 23, received severely lacerated wound to knee area on April 12, 1937. Admitted to hospital immediately and received prophylactic gas and tetanus serum. The following day gas infection was evident. Received two x-ray treatments per day for three days. Patient responded promptly to radiation therapy and, in spite of the severe laceration, no amputation was done—skin graft was finally necessary.

The x-ray reproduction shows gas in the tissues (Fig. 4). Clinical photograph shows the extent of the injury (Fig. 3). Organisms cultured from this wound were used to infect the guinea pig, the film of which shows gas in the soft tissues of the left thigh and left sacral region (Fig. 5). The pig died from gas infection in spite of x-ray therapy. The animal experimental work with gas organisms has never given as satisfactory results as have been obtained clinically. The guinea pig may be hypersensitive to the infection. At any rate those who refuse to treat their patients because the animal experimental work is not successful are making a serious mistake. In this instance the same organism that killed the guinea pig responded very well in the human.

24 hours of their disease. Never refuse to treat any patient because he is apparently a hopeless case, but in these seri-



Fig. 6. A. H. B., white male, aged 23, fell from the third story in construction work, sustaining a compound fracture of the middle third of the left femur. The following day gas infection was apparent and x-ray treatments were given over the proximal end of the femur and the left side of the abdomen to prevent extension of the infection. The leg was not treated.

Since it is the toxemia which kills, we feel that all the involved area should be treated, as toxin is being formed in all of the infected tissues. Therefore, it is not sufficient to treat only the upper border or just a part of the infected tissue. In our first report, in 1931, we stated that all suspected tissue should be treated with x-ray with sufficient kilovoltage to penetrate the area involved and that these treatments should be given twice each day.

This patient had sufficient reason to die from his injury, but was placed among the gas gangrene deaths as we felt from the clinical record submitted that he undoubtedly died from the gas gangrene. Treat above and below the site of injury; treat wherever you think toxins are being formed.

ously toxic cases in which treatment is started late, such as the case reported by our late colleague, Dr. Willis Manges, it requires

courageous measures and persistence on the part of the radiologist. From the record on this case, it is apparent that in less capable hands this patient would have undoubtedly died, but Dr. Manges' final switch to heavier voltage and greater filtration and the inclusion of more areas was promptly rewarded by a distinct improvement in his patient's condition. In the late cases it might be well to treat three times the first day or treat every five hours for three doses, if it can be arranged.

From the recent work of Pasternack and Bengtson (9) who show the toxin of *Vibrio* septic has powerful cardiotoxic properties, if not a special affinity for the heart, it might be well to treat directly over the heart as well as the other involved tissues in cases in which treatment must be started late in the course of the disease. These workers also show lesions in many other organs and, as they are continuing their study in the anaerobic infections, undoubtedly they will give us some definite guides in the treatment of this mixed group of infections.

#### THE STATUS OF THE X-RAY IN TREATING INFLAMMATORY DISEASES

It was called to the writers' attention by the late Dr. Willis Manges that the apparent specific action of the x-ray in treating gas gangrene was the first indisputable evidence the radiologist had to support his contention that the x-ray was of value in the treatment of the inflammatory lesions.

For many years many radiologists of mature clinical judgment had the value of the x-ray clearly demonstrated in treating a great variety of infections, but the clinician refused to be convinced and would generally claim that the patient recovered because of other measures employed in the treatment or that the lesion was self-limited and that the patient would have recovered without any treatment. The radiologist was generally obliged to admit that there was some truth in these statements. However, in gas gangrene we are dealing with an infection which up to this



time has resisted all forms of direct therapy. The only treatment known to be consistently effective was the complete re-

grene, in his opinion, established beyond doubt the status of the x-ray in the treatment of inflammatory diseases.



Fig. 7.



Fig. 8.

J. D., white male, aged 58, admitted to hospital suffering from an untreated diabetes of five years' duration and gangrene of both feet (Fig. 7). Patient cut a corn on his right foot April 27, 1937. This started a gangrenous process. X-ray film (Fig. 8) of right foot on May 14, 1937, showed gas in the tissues near heads of fourth and fifth metatarsals.

On May 27, 1937, after several days of pre-operative preparation including some x-ray treatments to both legs, the left leg, which was the lesser involved of the two, was amputated just below the knee. The stump of the left leg was treated following amputation but the next day the patient appeared toxic and showed a rise in temperature which suggested reactivation of the gas infection. The gangrenous area on the right foot was then included in the x-ray treatments and the toxic feature immediately cleared up. It is possible that the x-ray treatments controlled the toxin formation in the stump of the left leg, but the shock of the operation permitted the gas organisms to become active in the right foot and this, in turn, was controlled by x-ray when this area was treated; at any rate, he improved. The left stump progressed normally and the right leg was amputated on June 2, 1937. Both stumps were then treated until June 7, 1937, when x-ray was discontinued as there was no evidence of gas infection in either stump and the patient appeared to be in good condition.

The patient died one week later and postmortem showed evidence of active gas infection which had not been observed by the clinician and had not been reported to the x-ray department.

This case indicates the necessity of treatment over a long period of time because a reactivation of the infection may occur. If reactivation should occur, immediate x-ray treatment is imperative. This type of patient requires close co-operation between internist, surgeon, and radiologist, and even then may die of his disease. This type belongs in a separate group entirely from the gas-forming infections following injuries and its management is much more complicated. During the course of such a case as this, one is impressed with the value of the x-ray in controlling the apparent toxic condition of the patient while the organisms remain and again become active toxin-producers with each new shock.

removal of all the infected tissues, and the patient invariably died very soon unless the removal of the infected area was accomplished. Dr. Manges claimed that in gas gangrene we had an infection which was neither self-limited nor influenced by any other measure, and up to this time very rarely recovered without removal of the diseased part. The prompt and consistent action of the x-ray in gas gan-

#### SUMMARY

Since August, 1928, we have treated cases ourselves and collected data from various radiologists and surgeons throughout the country on 143 cases of gas gangrene infection treated with x-ray. The data bearing on the treatment were analyzed, and the conclusions formerly drawn are substantiated. No case which has been treated according to the suggestions con-

tained in the report in 1931 has died of gas gangrene.

The lowered mortality and the number of recoveries in the non-amputation group and in the no-serum group proved beyond question that the use of the x-ray in treating gas gangrene approaches the action of a specific in that it is by far the most effective measure so far employed. There are no contra-indications to its use by a qualified radiologist.

Severe débridement measures are no longer justifiable.

We cannot over-emphasize our opposition to amputation because of gas gangrene and feel that anyone amputating or advocating the amputation of an extremity solely because it is infected with a gas-forming organism is definitely out of touch with the proper and conservative treatment for the condition.

In addition to lowering mortality, we are certain that many arms and legs have been salvaged for the patients who recovered. A low mortality rate is no longer the sole standard of successful treatment of gas gangrene, if it has been obtained at the sacrifice of many extremities. We suggest that in the future a strict score on amputations be recorded and the number of amputations as well as the deaths be included in reports concerning methods of treatment in this group of infections.

Concerning the question of diagnosis in the cases treated with x-ray we might, for the benefit of the ever skeptical surgeon, mention the fact that there were 17 cases with sufficient evidence of gas gangrene to warrant the surgeon's removal of an extremity for gas gangrene, and surely no surgeon would amputate without satisfactory evidence that the patient had a gas-forming infection. But in this group of 17 cases of undoubted gas gangrene, only two died, a mortality of 11.7 per cent, which some time ago would have been considered a very satisfactory record. It should be even more convincing when, as pointed out in previous reports, some of these patients still had gas in the tissues above the site of amputation.

Some patients recovered following two or three x-ray treatments, but they were treated early in the disease. Animal experimentation also proved that early treatment was extremely effective. With these factors in mind the division of the cases according to the clinical phase in which treatment was started seems indicated, and they were, therefore, divided into suspected cases, early cases, and late cases. If treatment is started while the case is still under suspicion or before a definite diagnosis has been made, it should not develop gas gangrene. If treated early, that is, during the first 24 hours of the disease, there should be a 100 per cent recovery. By use of the x-ray film one may make a diagnosis very early, with the first accumulation of gas in the deep tissues, and this method of examination is essential if gas gangrene is suspected. We advise prophylactic use of the x-ray in suspected cases; in fact, in all types of injuries such as commonly develop gas gangrene infections.

Patients complaining of an unusual amount of pain following a hypodermic might well be x-rayed for gas in the deeper tissues, as this infection following hypodermic injection has been reported in the literature.

If treatment is started after the first period of 24 hours has elapsed, recovery will not be so certain and it is likely that 10 or 15 per cent of these patients will die. Since it is the toxin which kills and toxin is being formed in all of the infected tissue, it is absolutely essential that all the involved tissue be treated. The use of the x-ray in treating gas gangrene has definitely settled the contention of the radiologist that the x-ray is of value in treating inflammatory lesions, since no other treatment has ever been effective when directly applied to the involved tissue in gas gangrene. The usual method was removal of the infected part if the patient was to recover—if x-ray treatments are given this is no longer necessary.

In order to give the surgeon some support in a more conservative measure, such

as the use of the x-ray, it will be necessary to establish the procedure in the literature, and, therefore, a plea is made for all to report their cases in detail through some source or other, preferably their state and special journals.

The x-ray has also been of benefit in treating the arteriosclerotic, diabetic cases developed the complication of gas gangrene.

The use of serum is not absolutely essential to recovery, and its use should be conservative, avoiding serum sickness, which only adds to the patient's difficulty. Tetanus serum must be given.

Some filter and adequate kilovoltage to penetrate the involved part must be used.

Up to this time no patient has died of gas gangrene who has received a treatment in the morning and a treatment in the evening for three days over all of the involved tissue.

The analysis of the data so far available in connection with the x-ray treatment of gas gangrene seems to prove that x-ray treatment, properly given, is the answer to the question of what to do in treating a gas-forming infection. The space factor and the variable growth cycle of the organisms in the inflammatory lesions are briefly discussed in relation to the original method of two x-ray treatments each day.

These conclusions would not have been possible had it not been for the generous

co-operation of many clinicians in various parts of the country who were kind enough to contribute data on their cases. The procedure of soliciting other clinicians' material is not looked upon with special favor by the writers, but in view of the arms and legs and probably the lives at stake in this problem it seems to have been justifiable. The writers wish to acknowledge the generous co-operation of all those who contributed in any way to this presentation and they number well over a hundred physicians in 25 States of the Union and one Province in Canada.

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## CASE REPORTS

### BILATERAL SYMMETRICAL EXOPHTHALMOS DUE TO RETROBULBAR LYMPHOSARCOMA

#### REPORT OF A CASE

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The occurrence of acquired bilateral symmetrical exophthalmos is usually due to hyperthyroidism and only rarely to retrobulbar lesions. Unilateral exophthalmos due to a variety of retrobulbar lesions is not rare, but so far as we could determine, no reference has been made to the clinical picture described below.

#### CASE REPORT

Mrs. M. M., white, aged 55, entered the St. Vincent Charity Hospital on April 18, 1934, complaining of swelling of the neck and bulging of the eyes. The patient had noted a small, firm swelling in her neck one year previous to admission. This swelling was painless, non-tender, and gradually became more firm and larger. About six months later the patient noted increased prominence of the eyes associated with impairment of vision, nervousness, and occasional night sweats. At this time the swelling in the neck increased rapidly. There had been no tremor of the hands, and the appetite had been only fair. Three months prior to admission the eyes became "sore" and reddened. There had been a weight loss of 45 pounds in the previous year.

Physical examination revealed a moderately obese white female, aged 55, with marked bilateral, symmetrical exophthalmos, edematous, and diffusely injected conjunctivæ, and puffy and sagging lower lids. The temporal fossæ were filled with diffuse, smooth, firm, non-tender masses, and nodular tumors composed of enlarged, firm, fixed, and matted lymph nodes were present in the neck. The axillary and inguinal nodes were similarly involved. There was dullness to percussion over an area extending 2 cm. beyond each side of the sternum in the aortic region and a firm, non-tender, rounded mass about 4 cm. in diameter was palpable in the epigastrium. Firm nodular masses could be felt on each side of the pelvis through the rectal wall, and there was a red and brawny swelling of the right foot and ankle. A slight secondary anemia was present, and only 3,000 white blood cells per cu. mm. of blood, of which 79 per cent were poly-

morphonuclear leukocytes. No abnormal blood cells were found. A biopsy of one of the cervical nodes revealed lymphosarcoma.

On the suspicion that the cause of the exophthalmos was retrobulbar tumor, the left retrobulbar region was given approximately one-half of an erythema dose of x-ray, and within 12 days the exophthalmos in that eye had considerably diminished, while the exophthalmos of the right eye persisted. X-ray therapy to the other eye resulted similarly in prompt diminution of the exophthalmos and in improvement in vision. The mediastinum, the cervical, axillary, and inguinal regions were then treated, and by July 8, 1934, the day of discharge, the masses had nearly disappeared.

The patient was followed in the out-patient department and was re-admitted to the hospital on July 20, 1934, because of swelling of the legs. There was no exophthalmos, but the cervical, axillary, and inguinal nodes were again enlarged, the largest node in the left axilla measuring 3 cm. in diameter. The white blood cell count on this admission was 5,100, with a normal differential picture. X-ray therapy was continued but gave only slight beneficial results. The patient began to lose weight and by the end of the forty-fifth hospital day firm nodules measuring from 0.5 cm. to 1 cm. in diameter were palpable beneath the skin in almost every region of the body. The patient insisted on leaving the hospital and was re-admitted on Oct. 28, 1934, with marked dyspnea, ascites, and edema of the lower extremities. There were signs of fluid in both pleural cavities, more on the left. There was moderate exophthalmos, and the lymph nodes everywhere were enlarged. The white blood cell count at this time was 2,350. About 2.2 l. of turbid, yellow fluid were aspirated from the pleural cavities and 4.8 l. of similar fluid, from the abdomen. Cultures of these fluids yielded no growth. The patient declined rapidly and died on the fifteenth day of the third admission.

At autopsy, all lymph nodes were found greatly enlarged, discrete, of a flattened, rounded shape, pink in color, and soft in consistency. They varied from 1 × 2 × 2 cm. to 1 × 5 × 7 cm. in size and were occasionally densely adherent to surrounding structures. The histologic picture of these nodes was that of lymphosarcoma. Similar neoplastic involvement was found in the peri-orbital fat which contained nodules 0.5 to 1.0 cm. in diameter. Lymphosarcomatous infiltration was also present in the following situations: diffusely throughout the peritoneum, the

perirenal tissues on the left side, the periureteral tissues, the mesentery, the temporal muscles, and the choroid plexuses. It is of interest that no tumor was found in the spleen.

Turbid yellow fluid was present in both pleural cavities, and bronchopneumonia was found in the lower lobe of the right lung. There was also a generalized fibrino-purulent peritonitis caused by the pneumococcus.

#### CONCLUSION

A case of generalized lymphosarcomatosis with bilateral symmetrical exophthalmos due to retrobulbar lymphosarcoma is reported. The exophthalmos disappeared completely after x-ray therapy, but reappeared shortly before death. At autopsy, lymphosarcomatous tissue was demonstrated in the retrobulbar fat.

### FRACTURE OF THE TIBIA IN SPINA BIFIDA VERA

#### REPORT OF TWO CASES

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Neuropathic lesions in the lower extremities developing in patients with spina bifida vera are well recognized. Perforating ulcers of the feet and neuropathic joints have been described. The changes observed following fractures of the tibia in two of our patients with spina bifida vera, club foot deformities, and sensory disturbances of the lower extremities are of sufficient radiographic interest to warrant reporting.

Case 1. J. W., a girl five years old, was readmitted to the hospital on July 12, 1937, with a provisional diagnosis of sarcoma of the left leg. This child had previously been treated in the Department of Orthopedics for bilateral club feet associated with spina bifida vera. She was last seen by them in January, 1937, and was sent home wearing short leg braces.

*Present Illness.*—On June 20, 1937, the child began to complain of aching pain along the medial aspect of the upper third of the right leg. Five or six days later the mother noticed swelling on the lateral surface just below the knee. When off her feet the swelling would subside and pain was relieved. A week before admission it was noted that swelling was constant. There was no history of a specific trauma although the child was awkward and fell frequently.

*Physical Examination.*—The child was a well developed, and well nourished girl of five.

Examination of the back showed a large spina bifida vera at the level of the twelfth dorsal, first and second lumbar vertebrae. The accompanying soft tissue tumor measured 14 × 12 cm. in size. The right leg showed a large



Fig. 1. Anteroposterior and lateral views of the right leg of Case 1 showing nearly obliterated fracture line in upper tibia, extensive periosteal reaction, and excessive callus which has displaced the fibula.

mass 9.5 × 9.5 cm., located along the lateral anterior and medial aspects of the upper third. This was attached to the deep structures but not to the skin. There was no tenderness to palpation. The overlying skin was tense, hyperemic, and definitely warmer than the corresponding area on the left leg. However, the mother stated that the right leg had always been warmer than the left.

*Neurologic Findings.*—There was complete anesthesia of the lateral, and reduced sensibility of the medial aspect of both legs. The knee jerks, tendo-Achilles, and plantar reflexes were absent. It was felt by the examining neurologist that the sensory reduction and absence in the lower extremities would allow a fracture in the upper right tibia to cause very little discomfort.

*Radiographic Examination.*—Anteroposterior and lateral films of the right leg showed definite

enlargement of the upper leg below the knee (Fig. 1). There was a transverse, somewhat irregular fracture line 3 cm. below the upper end of the tibia. The fragments were in full apposition. Posterior and medial to the frac-

reactive bone formation. Diagnosis: Cartilage and osteoid tissue."

Case 2. M. N., a girl of five and one-half years, had also been treated by the Department of Orthopedics for a right club foot. The history states that the child was born with a spina bifida vera which had been operated upon when she was two days old. When last seen by them on Aug. 10, 1936, the club foot deformity was well corrected and the child was in good health. She was again brought to the hospital on Dec. 3, 1937, for consultation and radiographic examination. History and physical findings are not available to us as treatment was carried out elsewhere. We have learned that the Kahn and Wassermann tests were negative and that there was impaired sensation of the lower extremities. Reports of roentgenographic films previously taken elsewhere and not seen by us are as follows:

"April, 1937. Anteroposterior and lateral views show a fracture situated 1.5 in. distal to the epiphyseal line of the left tibia. No displacement."

"June, 1937. Anteroposterior view shows in the left tibia a fracture located 1.5 in. below the epiphyseal line. There is considerable callus formation present."

"August, 1937. Anteroposterior and lateral views show the fracture as described previously but it appears there is some involvement of the inner side of the epiphyseal line. There is abundance of callus. In this view there is also a fracture of the lower tibia just one inch proximal to the epiphyseal line. Good alignment with callus formation."

**Radiographic Examination.**—Anteroposterior and lateral films of the left leg made by us on Dec. 3, 1937 (Fig. 2), showed no fracture line to be present either at the upper or lower end of the shaft of the tibia. The cortex along the entire shaft of the tibia was dense and greatly thickened. It varied in thickness from 5 mm. in the midportion of the shaft to 10 mm. in the lower end posteriorly. The epiphyseal line of the upper end of the tibia was widened. The metaphysis was fragmented and displaced slightly laterally except for one fragment 10 × 13 mm. in size which appeared to remain attached to the epiphysis. The upper end of the fibula was also displaced laterally 5 mm. The diagnosis of bone syphilis was entertained until knowledge of available clinical data was obtained.

#### COMMENT

The principal interest in these cases lies in the fact that they demonstrate a complicating factor in the diagnosis of fracture of the tibia when there is sensory impairment in the lower extremities associated with spina bifida vera. In Case 1 the clinical picture was more sug-



Fig. 2. Anteroposterior and lateral views of left leg of Case 2 showing thickened cortex, fragmentation, and sclerosis of metaphysis with widening of epiphyseal line

ture there was a mass of new bone 2.5 cm. in its superior-inferior, 1.5 cm. in its anteroposterior, and 1 cm. in its lateral diameter. This newly deposited bone showed no evidence of striation or trabeculation. In the anteroposterior view the upper end of the fibula was displaced laterally 1 cm. There was marked periosteal reaction along the tibia for a distance of nearly 10 cm. There was no evidence of destruction of the old cortex and no break in continuity except at the fracture site. It was the opinion of the radiologist that this was a simple fracture with excessive callus formation but that there was sufficient doubt in the diagnosis to warrant a biopsy. The biopsy was done on July 15, 1937, and a small amount of osseous tissue was removed. This had the gross appearance of ordinary callus.

**Pathologic Report.** "Both cartilage cells and osteoblasts are normal-appearing. The histologic findings are explained on the basis of

gestive of sarcoma than fracture. A deep-seated tumor attached to bone was present. The overlying skin was movable and reddened. Pain was aching in character and aggravated by use of the extremity. There was no history of adequate trauma, no crepitus or false point of motion, and no point tenderness such as would be expected with fracture. After roentgenographic examination there was still sufficient doubt in the diagnosis to warrant a biopsy.

In the roentgenograph made by us in Case 2 the cortical thickening of the shaft, the irregularity and sclerosis of the metaphysis have more the appearance of bone syphilis than old fractures. We believe that without knowledge of the previous roentgenographs showing fractures, a negative Wassermann, and sensory impairment of the lower extremities, that the correct diagnosis could not have been made from our films. It should be noted that the club foot deformity in this patient was on the right, and the fractures were on the left.

In our opinion the etiology of the complicating factor in our two cases is similar to that seen in joint lesions in tabes and syringomyelia. Decreased sensibility allowed use of the extremities even in the presence of fracture, thus producing sclerosis, fragmentation, and excessive callus formation which complicated the diagnosis.

We wish to express our appreciation to Arthur Steindler, M.D., for permission to report these cases.

## SURGICAL EMPHYSEMA, PNEUMOTHORAX AND PNEUMOPERITONEUM

### A ROENTGENOGRAPHIC STUDY OF A CASE

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Surgical emphysema, pneumothorax, and pneumoperitoneum occurred, in this case, in the course of a closed ether anesthesia administered for the removal of a foreign body within the esophagus. Roentgenographic studies revealed not only the extent of the distribution of the ether vapor within the body, but gave some hint as to the anatomic pathways followed by the gas in its permeation through the various tissues.

### CASE REPORT

G. S., a boy four years of age, was admitted to the Mount Sinai Hospital on July 1, 1937, with a history of having swallowed a five-cent piece 36 hours previously. He complained of considerable pharyngeal discomfort and a fluoroscopic examination made in a private laboratory, two hours before admission to the

hospital, revealed the coin to be within the esophagus about two inches below the hypopharynx. It was felt advisable to remove it immediately by esophagoscopy. Ether anesthesia was administered through nasal catheters, the tips of which extended into the nasopharynx. There was some difficulty in maintaining the patient properly under the anesthetic and it appears probable that for a short time the ether vapor was fed at an excessive pressure. After about five minutes, it was noticed that the patient was developing a surgical emphysema of the face, neck, and shoulders, and the anesthetic was discontinued. That night and on the following day the patient showed slight dyspnea, considerable restlessness, and was bothered by excessive mucus in the throat. The temperature was  $101^{\circ}$ , pulse 120, and respirations 28. Clinically there was a well-marked surgical emphysema involving the face, neck, shoulders, chest, abdomen, and back down to the mid-thigh. X-ray studies were made on the following three days. With absorption of the gas, the boy's symptoms gradually cleared up and he was discharged on July 6. The coin, which as a result of the relaxation associated with the anesthesia, appears to have slipped down into the stomach, was passed by rectum on the eighth day.

### ROENTGEN FINDINGS

Over the abdomen, chest, and back the distribution of the gas was, for the most part, subcutaneous—slightly more marked on the left side. There was some collection of gas between the chest wall and scapulae. Various muscle bundles in the neck were clearly visualized because of infiltration of the gas in the interfascial spaces.

The chest showed a definite mediastinal emphysema slightly more marked on the left side. The trachea was in the mid-line. The left lobe of the thymus was clearly outlined by gas distributed around it. The anterior border of the left lung was clearly visualized. The left border of the descending aorta was sharply demarcated by gas which tended to form a bulb-like collection just above the diaphragm. There was a small amount of gas in the left pleural cavity visualizing the outer border of the left lung up to the second rib.

The abdomen showed an unusually clear visualization of both kidneys due to distention of the perirenal fasciae by gas. The psoas muscles stood out in bold relief. The peritoneum appeared dissected off the abdominal wall, especially in the left lower quadrant. A small amount of gas could be seen within the peritoneal cavity outlining the right border of the liver and under the left dome of the diaphragm outlining the spleen. A small amount of gas

was present over the buttocks and between the muscle bundles of the thighs.

I was puzzled to account for this extensive distribution of the gas until the work of Macklin, with experimental over-insufflation of the

ized subcutaneous emphysema, the presence of air in the mediastinum, about the aorta and the esophagus, and in both pleural cavities. There was also some air in the peritoneal cavity and in the sub-peritoneal structures, particularly



Fig 1. Roentgenograph showing infiltration of the gas through the various tissues of the neck, chest, and abdomen. *A*, Gas in the subcutaneous tissues and between the various muscle bundles of the neck. *B* and *D*, Mediastinal emphysema outlining the anterior border of the left lung and the left lobe of the thymus. *C*, Gas between the chest wall and the scapula. *E*, Partial left pneumothorax. *F*, Gas extending along the left border of aorta toward the diaphragm. *G* and *H*, Gas under the right and left domes of the diaphragm. *I*, Gas in the perirenal fascia outlining the kidneys. *J*, Coin within the stomach.

lungs in animals, was brought to my attention. Macklin insufflated the lungs of a cat by means of a catheter extending through the trachea, with blasts of air under pressures varying from 2 to 10 mm. of mercury. When the pressure was kept up for a sufficiently long time, he would find, at autopsy, in addition to a general-

large blebs of air collecting around the loose tissues of the perirenal fascia. By means of a serial section of the hardened specimens of the lungs he was able to demonstrate an interstitial emphysema about the perivascular sheaths.

Macklin believes that the pathway followed by the gas in the over-distended portion of the



lung into the pleural cavity is not directly through the visceral pleura, as might be supposed, but by a more devious route through tiny openings in the alveoli into the interstitial tissues, hence along the perivascular sheaths of the lung into the mediastinum. The latter is gradually distended until rupture, usually of insignificant size, takes place at various points. Air then finds its way upward into the base of the neck, axillæ, and subcutaneous tissues of the trunk. Laterally, by rupture of the mediastinal pleura at the root of the lung, air enters the pleural cavities. If pressure is continued, the air dissects its way downward along the esophagus and aorta into the retroperitoneal tissues and perirenal fascia. Ultimately there is rupture of the peritoneum with entrance of air into the peritoneal cavity.

The distribution of the gas in the experimental animals, as compared to that in our patient, offers such a striking parallelism as to leave little doubt that the pathways followed must have been the same. The problem that naturally suggests itself is whether or not pus, originating in the mediastinum or reaching it from the neck or lungs, might not, under certain conditions, follow a similar pathway. The other question to be considered is whether or not this might offer a new concept for the method of production of spontaneous pneumothorax rather than the older conception of direct rupture through the visceral pleura. Macklin and others are inclined to this view. It might be well to keep in mind, however, that

what holds true for sudden over-insufflation of a normal lung need not hold true for chronic distention of a diseased lung. In a spontaneous pneumothorax brought about in this manner one must expect, of necessity, a preceding mediastinal emphysema and rupture. One would look, therefore, for a frequent occurrence of an associated emphysema of the neck and face in these cases as well as roentgenographic evidences of mediastinal emphysema associated with the pneumothorax. Either of these eventualities is, in my experience, uncommon. It would appear, therefore, that while spontaneous pneumothorax might, and possibly occasionally does, occur in this way, it is probably not the usual method of its production.

#### SUMMARY

Extensive surgical emphysema, pneumothorax, and pneumoperitoneum occurred in this case in the course of a closed-ether anesthesia. By analogy with animal experiments, the probable pathway followed by the gas is traced. Certain clinical implications suggested by the existence of this pathway are discussed.

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## REPORT OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY<sup>1</sup>

Your Inter-Society Committee was created to provide a national headquarters for all American radiology. Its function is to collect facts and information, to make this information available to members and local groups, and to offer advice and counsel when requested. Through this national office of American radiology, organized radiology is able to present its case to the American Medical Association, and the American Hospital Association, and other national agencies. Likewise, it is able to keep in touch with the activities of these agencies, to evaluate their effects upon radiology, and to interpret trends as they bear upon the welfare and progress of radiology.

There are several particular items of successful activity upon the part of the Committee as a whole, of the Executive Secretary as a fountain of factual and analytical information, and of the earnest and sincere work of the individual faculties inherent in the members of this Committee, that will be detailed later.

Your Inter-Society Committee wishes to acknowledge the splendid help that it has received from many individuals who have rallied to the support of our program in various situations and localities. The Committee acknowledges the importance of the radiologists chosen from each State as a human liaison with the problems of each State. Confidential and reliable information has helped the Committee to avoid errors of judgment and permitted us to form opinions and make decisions that have stood the test of the resulting experience.

The Advisory Committee, composed of the secretary and chairman of the executive council of each of the supporting societies, has aided materially in the determination of policies and has helped the Committee to develop a confidence in the merit of the program as it develops.

The Committee has sent the Executive Secretary to a number of cities where local radiologists have asked for help in excluding their services from hospital schemes of insur-

ance and we are glad to report that these efforts have been successful in nearly every instance. We are not conscious of any complete defeat. We do know of innumerable victories. Details of such activities can be obtained from the Executive Secretary. They are too voluminous for this report.

At every opportunity we have urged and encouraged radiologists to improve their hospital arrangements. The Committee cannot force an individual hospital to revise an unfair contract with its radiologist but it can influence the local situations by calling attention to the resolutions of the Councils and House of Delegates of the American Medical Association that defend our ambitions to avoid the exploitation of radiological practice. The only pressure that organized medicine has at its disposal in defeating unfair practices and tactics by hospitals is through the approval listing of hospitals, internships, and residencies by the Council on Medical Education and Hospitals of the American Medical Association.

The Committee feels that real progress has been made in cementing the problems of radiology into the whole picture of the American medical profession. The healthy attitude of the House of Delegates and the splendid co-operation of the various Councils and the favorable action of the Board of Trustees and of the National Secretary, Dr. Olin West, are indications of the usefulness of this Committee to radiology. The actual facts of the proceedings at the San Francisco meeting of the American Medical Association have been printed in both the national journals. The Journal of the American Medical Association made these resolutions a matter of editorial comment.

The Committee has prepared, and this only through the capable Executive Secretary, two important documents for publication in the national journals. One is based upon "The Modern Hospital and its Relations to the Practice of Medicine." This is factual and carries citations to support the contentions. The ever-increasing activity of the hospitals and their national organizations and publications to establish medical practice by hospitals,

<sup>1</sup> Presented by E. H. Skinner, M.D., before the annual meeting of the American Roentgen Ray Society, Atlantic City, Sept. 22, 1938.

makes this an important contribution in support of our demand that radiology continue as medical and not hospital practice. The other article is titled, "What Is the Issue."<sup>2</sup> This is a more timely exposition of the most recent editorial opinion of hospital enthusiasts and furnishes the radiologists with ammunition and argument to controvert the specious claims of omni-service by hospitals. We direct your attention to these two items. They are to be followed by others. We would like to feel that the membership would support our requests for prompt printing of such informative articles by the journals controlled by our societies. We would not wish to sacrifice the most important scientific contributions but we do feel that the present stress and strain of the times warrants some stress upon the economic factors of radiological practice. We believe that members want these items. We would cordially invite an expression from the membership upon this point.

The Committee wishes to acknowledge the help and the cordial co-operation of various executive committeemen from the several societies in the development of standards of radiological practice. Such standards must be erected for the benefit of the Council on Medical Education and Hospitals if it is to carry out the instructions of the 1938 House of Delegates by imposing restrictions to influence hospitals that persist in exploiting any type of medical practice. This is a long-time problem and its solution seems to depend at this time upon the solidarity of the American Medical Association. If the influence of this parent organization is weakened or dissipated, our problems will be multiplied and perhaps stultified.

This report could be expanded into a volume if it attempted to detail the various and sundry activities of the committeemen and the Executive Secretary. This seems absolutely uncalled for and if any individual member wishes specific information, the Executive Secretary and the Committee will be only too glad to make the effort to completely satisfy that member. It now seems expedient to pass from the practical exposition of performance to the dreams and implications of the future.

The Committee believes that the following items represent the problems that threaten the welfare of the medical profession and radiological practice:

- (1) The attitudes and practices of hospitals

<sup>2</sup> RADIOLOGY, p. 491, October, 1938.

and the organized hospital world which tend to place radiology under the domination of a lay board of trustees, establishing it as a technical service to be rendered by hospitals instead of a professional service to be rendered by private physicians;

- (2) The attempts to define radiology as a hospital service by including it among the hospital benefits offered in group insurance plans;

- (3) The tendency for some hospitals to look upon the department of radiology as a legitimate source of revenue to pay losses sustained in other departments, thus depriving the radiologic department of a portion of its legitimate income;

- (4) The attempts to dismember radiology and consequently destroy the specialty by dividing it into technical and professional stages;

- (5) The increase in group and co-operative laboratories which supplant established and trained radiologists engaging in private practice;

- (6) The threat of competition by the state through free diagnosis and treatment of cancer, and general diagnostic centers, thereby discouraging private enterprise and individual initiative by radiologists.

Let it be emphasized here that when the Committee approaches problems in medical economics it is not primarily concerned with the fact that some new development may curtail the income of an individual practitioner. It is, however, concerned with the fact that these developments may injure the growth of radiology, decrease the quality of the service to be offered to patients, and discourage the attraction of competent new matriculates to the field.

In appraising those problems which concern every practising radiologist it becomes necessary to first assemble some facts and evaluate some trends. The analysis of these facts and trends has occupied a large portion of the time of the Committee and its Secretary, Mr. Cahal, during this first year of its existence. To obtain facts we have distributed a questionnaire to the 1,500 members composing the four parent societies. The tabulation of the nearly 1,000 returns received represents a big task and, even with the help of the statistical department of the American Medical Association, we are not yet in a position to present to you at this time the results of this study. The

full report will be published within a short time. Also in pursuit of facts we have distributed numerous inquiries to our mailing list of state representatives. In addition, we have carefully studied all factual reports issued by other official bodies in the medical, hospital, and political fields in search of information which will help us to measure accurately the status and the problems of radiology.

To evaluate trends properly and thus to chart a proper course of action for the future, we have maintained a close association with the American Medical Association, the American Hospital Association, and other such agencies, for the purpose of observing actions relating to radiology and insofar as possible of assisting in the guidance of those actions. In anticipation of a federal sickness insurance program, which the most sanguine conservative must admit is a foregone certainty, we are making every effort to predict and to help establish the position of the radiologist in medical practice when, and if, such a program is instituted.

All these facts, in the form of bulletins, journals, reprints, and statistical surveys are being collected, indexed, and filed in our headquarters office. In the meantime we have established a focal point of contact between all organized radiology and the national associations representing other specialties, organized hospitals, and the American Medical Association. Illustrative of the value of such association is the splendid report issued April 30, 1938, in the *Journal of the American Medical Association* by the Board of Trustees of the Association, previous to the San Francisco session of the House of Delegates, and which set the stage for the encouraging stand taken by the American Medical Association during the meeting on behalf of radiology. The Committee, through its Secretary, was given the privilege of supplying information to assist in the preparation of that report. Its approval by the House of Delegates marked a decisive victory in the fight by radiologists to maintain their specialty against threats of domination and exploitation by the lay boards of trustees of hospitals. Its influence in the determination of developments will be felt for a long time to come.

The chief problem which has confronted the Committee during the past year has been in connection with hospital insurance. Here arose a question of supreme importance to the

science and practice of radiology. Was radiology a technical service to be offered by incorporated hospitals as a part of hospital care on an annual premium basis, or was it a medical service to be provided by private physicians on a fee-for-service basis like other medical procedures? To repeated demands by this Committee and by the American Medical Association that medical services be excluded from hospital insurance schemes the American Hospital Association took an acrimonious stand and insisted that radiology was a part of hospital care and must be included as a part of hospital benefits in all such plans. Month after month their official journal has advanced principles to justify their contention that radiology is a service of, by, and for hospitals and as such must be included in the insurance plans.

While the record in combating this dangerous development is by no means perfect we are pleased to report that a successful defense has been waged. Several of the largest plans in existence to-day include radiology as a hospital service, but in the 30 or more plans adopted throughout the country during the past year only one or two has, to our knowledge, included radiology. The American Medical Association has taken a firm stand in support of the radiologist, the pathologist, the anesthetist, and others who object to a new development in hospital economics that will result in their specialty being taken over by the hospital. Throughout the past year the battle raged in Philadelphia between an adamant hospital council and a determined group of local radiologists and only within the past month were Philadelphia radiologists able to win their point. The Committee's Secretary spent much time in Philadelphia in assisting the local roentgen society. His services have been useful in similar fights in Denver, Kansas City, Michigan, Florida, and other localities where radiologists appealed for help in protecting their specialty against fundamental injury through the institution of hospital insurance schemes. Right now he is working with our members in Baltimore in an effort to obtain a correction of that plan and it is hoped that local groups in other communities who were forced to accept the wrong kind of a plan will take up the battle and, backed by the full support of the American Medical Association, insist upon a revision that will leave their profession in the same position as other medical

specialties. The credit for correction of the plans in California which originally included radiology belongs to a militant group in the Pacific Roentgen Society. These members have demonstrated what a positive program will do. The Inter-Society Committee could accomplish a great deal more if there were more of this type of aggressive local groups in all parts of the country.

The Secretary of the Committee, Mr. Cahal, has carried out his duties under the close supervision of the members of the Committee. While a large part of his time has been spent in travelling to various cities at the request of local roentgen groups it has been necessary for him to dispose of a large amount of work through the headquarters office. In addition to routine details and frequent conferences with councils of the American Medical Association and other agencies headquartering in Chicago, daily inquiries are received at our office from hospitals, medical societies, member radiologists, and social agencies calling for study and reply. Any such inquiry which involves a question of policy is referred to members of the Committee before action and if of sufficient importance it is in turn referred to our Advisory Committee, composed of the secretaries and Chairmen of Executive Committees of the four participating societies.

During the past year the Secretary has made one or more trips to the following places, either to attend a meeting or offer assistance;

Philadelphia, New York, Pittsburgh, Boston, Washington, Baltimore, Atlantic City, Denver, Los Angeles, San Diego, San Francisco. He has sat in conferences with medical society councils and addressed medical societies in Michigan, Illinois, Indiana, Missouri, Pennsylvania, and Colorado. Soon after starting his duties he visited Detroit, Cleveland, and other localities which offered convenient stopping places on other official trips. Next month he will visit Texas for a meeting with the state radiological society.

The editors of both your journal and of the *American Journal of Roentgenology and Radium Therapy* have generously agreed to set aside a regular department for monthly reports and articles by or sponsored by the Committee. This, we feel, is a more desirable and a less expensive way of keeping in contact with the members than by publishing a bulletin of our own. Through these regular reports we hope to keep every member thoroughly aware of important developments and to maintain a concert of opinion among the members of our own profession.

If it is to be properly represented in the profound changes taking place in the social and economic phases of medical practice, the profession of radiology must be thoroughly awake, strongly unified, and aggressively articulate. We feel that radiologists have these three things in the program of the Inter-Society Committee.

# RADIOLOGICAL SOCIETIES IN THE UNITED STATES

*Editor's Note.*—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—*Chairman*, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary*, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

*Los Angeles County Medical Association, Radiological Section.*—*President*, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president*, E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary*, Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer*, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

*Pacific Roentgen Club.*—At its recent Annual Meeting at Pasadena, the following officers were elected for the ensuing year: *Chairman*, Lyell C. Kinney, M.D., San Diego; *Member of the Executive Committee*, Irving S. Ingber, M.D., San Francisco; *Secretary-Treasurer*, L. Henry Garland, M.D., Suite 1739, 450 Sutter Street, San Francisco. The other members of the Executive Committee are: Lowell S. Goin, M.D., Los Angeles, and Alfred C. Siefert, M.D., Oakland.

*San Francisco Radiological Society.*—*Secretary*, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

## COLORADO

*Denver Radiological Club.*—*President*, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president*, Sanford Withers, M.D., 304 Republic Bldg.; *Secretary*, Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer*, H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—*Chairman*, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Vice-chairman*, Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer*, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

## DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

## FLORIDA

*Florida State Radiological Society.*—*President*, H. O. Brown, M.D., 404 First National Bank Bldg.,

Tampa; *Vice-president*, H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer*, J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

## GEORGIA

*Georgia Radiological Society.*—*President*, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president*, William F. Lake, M.D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer*, Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

## ILLINOIS

*Chicago Roentgen Society.*—*President*, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president*, Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer*, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

*Illinois Radiological Society.*—*President*, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president*, Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer*, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

*Illinois State Medical Society, Section of Radiology.*—The next meeting will be May 2, 3, 4, 1939, to be held in Rockford. The officers of the Section for the coming meeting are Harry B. Magee, M.D., of Peoria, *Chairman*, and Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago, *Secretary*.

## INDIANA

*Indiana Roentgen Society.*—*President*, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect*, Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president*, A. C. Holley, M.D., Attica; *Secretary-Treasurer*, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## MAINE

See New England Roentgen Ray Society.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.* *Chairman*, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary*, H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

## MASSACHUSETTS

See New England Roentgen Ray Society.

## MICHIGAN

*Delroit X-ray and Radium Society.*—*President*, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president*,

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

*Michigan Association of Roentgenologists.*—*President*, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

## MINNESOTA

*Minnesota Radiological Society.*—*President*, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

## MISSOURI

*The Kansas City Radiological Society.*—*President*, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—*President*, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

## NEBRASKA

*Nebraska Radiological Society.*—*President*, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

## NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

## NEW HAMPSHIRE

See New England Roentgen Ray Society.

## NEW JERSEY

*Radiological Society of New Jersey.*—*President*, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

## NEW YORK

*Brooklyn Roentgen Society.*—*President*, Albert Voltz, M.D., 115-120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.,

Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

*Buffalo Radiological Society.*—*President*, Walter Matlick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

*Central New York Roentgen-ray Society.*—*President*, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

*Long Island Radiological Society.*—*President*, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—*President*, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

*Rochester Roentgen-ray Society.*—*Chairman*, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

*Society of Radiological Economics of New York.*—*President*, Albert L. Voltz, M.D., 115-120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—*President*, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

## OHIO

*Cleveland Radiological Society.*—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; Vice-president, John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; Secretary-Treasurer, Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—President, B. M. Warne, M.D., Doctors Building, Cincinnati; Secretary-Treasurer, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—President, Charles S. Caldwell, M.D., 520 S. Aiken Ave., Pittsburgh; First Vice-president, Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; Second Vice-president, Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; Secretary-Treasurer, Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; President-elect, Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; Editor, William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

*Philadelphia Roentgen Ray Society.*—President, Thomas P. Laughery, M.D., Germantown Hospital; Vice-president, Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; Secretary, Barton H. Young, M.D., Temple University Hospital. Treasurer, R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

*The Pittsburgh Roentgen Society.*—President, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; Secretary, Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

## RHODE ISLAND

*See New England Roentgen Ray Society.*

## SOUTH CAROLINA

*South Carolina X-ray Society.*—President, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; Secretary-Treasurer, Hillyer Rudisill, Jr., M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## SOUTH DAKOTA

*Meets with Minnesota Radiological Society.*

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee State Radiological Society.*—President, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; Vice-president, Steve W. Coley, M.D., Methodist Hospital, Memphis; Secretary-Treasurer, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—President, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; President-elect, Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; First Vice-president, C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; Second Vice-president, M. H. Glover, M.D., 904 8th St., Wichita Falls; Secretary-Treasurer, G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

## VERMONT

*See New England Roentgen Ray Society.*

## VIRGINIA

*Radiological Society of Virginia.*—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; Vice-president, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; Secretary, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

## WASHINGTON

*Washington State Radiological Society.*—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; Secretary, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.



# EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

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## THE RESPONSIBILITY OF THE AMERICAN BOARD OF RADIOLOGY FOR SETTING UP AND MAINTAINING STANDARDS IN RADIOLOGICAL EDUCATION<sup>1</sup>

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We must remember that, primarily, the American Board of Radiology was organized to examine and certify to the competence of physicians who profess to specialize in radiology. Nevertheless, I think it will be agreed that the American Board of Radiology and radiologic standards are practically synonymous, for if the Board conducts examinations as they should be conducted it will automatically raise the standards of radiologic practice.

On the other hand, the Board cannot raise the standards of radiologic practice beyond the capacity of the teaching facilities that we have in this country. To emphasize that point I shall quote from the recommendations for graduate training in radiology that were adopted by the Board in Atlantic City last Spring. Under "B," the heading now reads: "Special training, to be effective January 1, 1940," but to-day the date has been changed to January 1, 1942. The requirement follows: "A period of study, after the internship, of not less than three years in an institution or radiologic department recognized by the same Council (the Council on Medical Education and Hospitals of the American Medical Association) and the Board of Radiology as competent to provide a satisfactory training in the field of radiology, or equivalent training acceptable to the Board."

Now in order to arrive at a conclusion as to what constitutes a satisfactory radiologic training and to compile and publish a list of those offering such training the members of the Board feel that we must make a survey of the radiologic training that is now available in this country. There is now just off the press a registry of diplomates of the American Board of Radiology. Every diplomate of the Board will receive a copy of this registry within the next few weeks. It will be accompanied by a

printed notice that the Board is attempting to compile a list of institutions or individual teachers offering graduate or post-graduate training in radiology, and that a questionnaire concerning the information desired will be sent on request. The distinction between graduate and post-graduate training that has been adopted by the Advisory Board for Medical Specialties and, as I understand, by the Council on Medical Education and Hospitals of the American Medical Association, is substantially as follows: By "graduate training" is meant a course of instruction over a long and continuous period of time, that is, from one to three years, while post-graduate education or post-graduate courses apply to shorter review or "refresher" courses of from a week to a few months such as are offered to physicians who have already had some experience or training in the specialty.

It is hoped and expected that all such institutions or independent instructors will ask for questionnaires. When they are filled out and returned they will furnish information to the Board as to the character of courses offered, type of instruction, teaching personnel, and the time devoted to various subjects, including physics, pathology and other basic sciences. From the total of replies the Board will obtain a definite idea as to the quality and amount of graduate training that is available in this country. Those who heard Dr. Holmes' Carman Lecture<sup>2</sup> at the International Congress of Radiology will realize, I am sure, that it is a very serious problem as to whether or not we actually have sufficient facilities for training an adequate number of radiologists.

After reviewing the questionnaires the Board may feel that it can give suggestions or advice to those offering training and thus help to improve the quality and extent of instruction in some of the institutions.

<sup>1</sup> Part of a symposium on radiologic training presented at the Eighth Annual Conference of the American College of Radiology, Chicago, Feb. 13, 1938.

<sup>2</sup> Published in RADIOLOGY, 29, 652-659, December, 1937.

There is another important function that we feel the Board can perform in raising the standards of radiologic training. For almost four years, since 1934, the Board has been examining applicants, and in that time has certified more than 1,100. Considering that large number, with more to come, I think it will readily be appreciated that the Board has some valuable data, and in the Secretary's office we are now in process of canvassing the data. For example, we can go through the files of candidates examined and select those applicants who were trained, let us say, at Institution X, perhaps fifteen or twenty in number. That number is sufficiently large to enable us to draw some conclusions as to the quality of training given by Institution X. On reviewing the records of these candidates in various branches of radiology it may become apparent that a considerable proportion of the applicants have not made too good a showing in gastro-intestinal roentgenology. If that is the case there is something wrong in the way that

gastro-intestinal roentgenology is being taught at Institution X, and the Board can be of definite help to the institution by pointing out the fact. Likewise, the trainees of some other school may fail to make a satisfactory showing in pathology or in physics and this information will be available to the institution concerned. I can assure all of you who want to know how the applicants you have trained are getting along with their examinations that we shall be glad to furnish you with the results on file in the Secretary's office.

It seems to me that in these ways the Board can probably contribute a great deal toward raising the standards of radiology, for those standards can be raised by improving methods of training. It goes without saying that the Board must conduct itself in a way that will not leave it open to criticism. I mean that our examinations must be rigid but fair, and I assure you that we are making every effort to keep them both rigid and fair.

B. R. KIRKLIN, M.D.

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## ANNOUNCEMENT

### PRESIDENT'S INVITATION TO THE ANNUAL MEETING

We wish to extend to all radiologists a cordial invitation to attend our Annual Meeting, Nov. 27-Dec. 2, in Pittsburgh. The headquarters will be at the Hotel William Penn.

The program has been arranged for general sessions during the mornings and separate sessions of diagnosis and therapy during the afternoons, which will permit of a more detailed discussion of the various subjects. The Clinics, which have always been a popular and important part of our programs, will be continued. A new feature this year will be the "Refresher Courses" on Sunday, all day, and Monday morning. These will be worth your attention.

The Carman Lecture will be given this year by William C. MacCarty, M.D., who is well known to all of us. Dr. MacCarty will discuss Cancer of the Stomach and his discussion of the ulcer-cancer relationship will be of particular interest to everyone.

In addition, we hope to have some of our

usual delightful social occasions which always add a great deal of pleasure to our meetings.

HOWARD P. DOUB, M.D.

*President of the Radiological Society of North America*

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## COMMUNICATIONS

### NORTHERN SOCIETY FOR MEDICAL RADIOLOGY

The Editor has received the following communication from Dr. Albert Soiland, of Los Angeles, California:

"The annual meeting of the Northern Society for Medical Radiology was held in Copenhagen, Denmark, on June 28, 29, 30, of this year. Approximately 200 delegates were assembled from Denmark, Norway, Sweden, and Finland. Dr. Swanson, of New York, and I were the only Americans present.

"Both the diagnosis and treatment of cancer were ably discussed by such men as Bakke, Dale, Bull Englestad, of Norway; Jönsson, Heyman, Edling, Wulff, of Sweden, and

Bichel, Nielson, and Kirketerp, of Denmark. A great deal of attention was paid to x-ray treatment of specific and non-specific arthritis, peri-arthritis, and neuritis, by Baastroup and Moltke of Denmark; Sandstrom, Kahlmeter, Renck and Westermarck of Sweden; Frimann and Dale of Norway, and Mustakalleo of Finland.

"Roentgen diagnosis in its wider ramifications was illustrated in a most interesting and instructive manner, notably by Akerlund and Westermarck of Sweden, and Wordenstoft, Westergaard, Licht, Christiansen, and Nørsgaard of Denmark.

"The modernized Finsen Institute, since my first visit there in 1905, has a remarkable record of achievement. From a modest beginning, Nils Finsen began the eradication of lupus vulgaris from Europe in 1900. What had been accomplished by him up to the moment of his untimely death, and by his followers up to the present time, was strikingly illustrated before the general assembly by the Institute's present leaders, Lomholt and Chievitz.

"Space does not allow a reference to the essays of all the delegates in attendance, but it was a well balanced program and well worth my journey of six thousand miles. This Ninth Annual Congress was under the direction of President P. Flemming Möller and his efficient local secretary, Jens Nielson, of Denmark.

"The General Secretary of the Congress was Carl Sandstrom of Sweden. The meetings were held at the Government Hospital (Rikshospitalet) at Copenhagen where the ample amphitheatre was well provided with effective projection apparatus for all types of slides, films, and illustrations. A feature was the motor-driven mechanism for shutting out all outside light and maintaining ventilation.

"Since the Hospital is located at the city's outskirts, the management served, gratis, at noon each day, breakfast 'Frokost' to the Danes. This consisted of an excellent hot meal accompanied by a bountiful cold table—and the Swedes have a name for it, 'Smorgas,' literally translated 'buttered goose.' In short, it is a regular American warm meal, plus an endless variety of cold cuts—meat, fish, vegetables, cheese, and fruit, garnished with artistic skill into a glorified maze of hors d'oeuvres. Naturally, the delegates were enthusiastic over this display of hospitality and voted three rousing cheers for their gracious hosts.

"During the sessions, your scribe presented an article, with slides, entitled 'Certain Aspects of Supervoltage X-ray Therapy with Comments.'"

#### GERMAN ROENTGEN SOCIETY

"The 1938 meeting of the German Roentgen Society was held in Munich, July 3 to 7, inclusive. The Society's meetings took place in the 'Kongresshalle des Ausstellungsparks,' meaning, 'The Lecture Hall at Exposition Park.' The building was new, commodious, and admirably constructed to serve large groups for lectures, instruction, and assemblies up to four or five thousand. Between the lectures one could ramble around the park or visit many interesting exhibits in the various buildings. Professor Karl Frik of Berlin, was President, and Dr. G. A. Weltz of Munich, Secretary General.

"Several noted medical guests were invited to sit at the administration table from time to time, and your scribe had the honor to direct proceedings during one of the afternoon sessions. My application for place on this program arrived too late to be included, and the program was already overcrowded, but I was, nevertheless, permitted to show some slides and make a few remarks on the management of cancer. Approximately 700 radiologists, surgeons, pathologists, and physicists were in attendance, and the program was excellent, with a little overbalance on highly technical subjects. There were a few delegates present from the various Scandinavian countries, also Austria, Hungary, Yugoslavia, Czechoslovakia, Switzerland, and Italy. No French nor English, and your scribe was the only American, the majority being, of course, Germans.

"The display of x-ray, electrical, and physical apparatus was impressive and a new type German million-volt x-ray generator elicited a great deal of interest. The social program was varied and ample."

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#### A NOTE OF CORRECTION

The authors of "Osseous Growth and Development," which was published in the October issue, desire to state that, on page 442, the heading, 'Boys—radius—head, advanced 6 mos.," should read, "Boys—radius—head, advanced 46 mos." The mistake in the artist's lettering was not discovered until the drawing had been printed.

## BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**MALIGNANT TUMORS OF THE SKELETAL MUSCLES, FASCIAE, JOINT CAPSULES, TENDON SHEATHS, AND SEROUS BURSAE.** By GUNNAR JÖNSSON. Supplement XXXVI to *Acta Radiologica*. A volume of 304 pages. Published by P. A. Norstedt & Son, Stockholm, 1938. Price: 20: Swed. cr.

**A HANDBOOK OF ROENTGEN AND RADIUM THERAPY.** By A. J. DELARIO, B.A., M.D., Radiologist, St. Joseph's Hospital, Paterson, N. J., and Community Hospital, Montclair, N. J. A volume of 362 pages illustrated with numerous engravings, graphs, and tables. Published by F. A. Davis Company, Philadelphia, 1938. Price: \$8.00.

## BOOK REVIEW

**RÖNTGENATLAS DER ASBESTOSE DER LUNGEN** (Roentgen Atlas of Pulmonary Tuberculosis). By DR. ERICH SAUPE, from the Radiological Department of the Rudolf Hess Hospital, Dresden, Germany. A volume of 99 pages, with 52 illustrations. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 21.50.

Dr. Saupe's well-organized book on asbestosis presents the subject matter in ten chapters. In the first, which is historical, he notes that medically, the disease has been recognized since about 1900. The second chapter contains beside the geology, mineralogy, and technology of the condition, detailed and careful discussion of the chemistry, and the author's belief that not silicic acid but the silicates are responsible for asbestosis. He also goes into the geographic localities and how, and by approximately how many persons, asbestos is mined.

In the third major division of the book, the

author describes the pathologic anatomy of pulmonary asbestosis. This is characterized by more or less diffuse fibrosis of lung tissue (in contradistinction to the nodular or tumorous appearance of silicosis) which increases from above downward, and which may cause pulmonary epithelium to be transformed into cube-shaped or cylindrical cells, and occasionally produces desquamative inflammation. The lymph glands may show fibrous induration.

The fourth chapter, on the clinical handling of the disease, is itself divided into (A) the patient's history, (B) objective clinical findings, (C) complications, (D) x-ray findings and differential diagnosis, and (E) asbestos needles and asbestos bodies. In subdivision (D), the author outlines his technic and differentiates the roentgen appearance of three stages and a pre-stage. He stresses the need for differential diagnosis of asbestosis and silicosis, silicatosis and tuberculosis, and gives his critique for so doing.

The remaining subject matter in the book is amply explained by the chapter titles, thus: 5, Dependence of Asbestosis on Time Worked in Asbestos Mines; 6, Prognosis; 7, Therapy; 8, Disposition (of Patient), Medical Prophylaxis, and Technical Precautions; 9, Asbestosis as Recompensable Industrial Disease, and 10, Bibliography.

There is ably developed, competent handling of the subject, and the book is a good one, of especial value to the roentgenologist interested in pulmonary or industrial diseases. According to Dr. Saupe, asbestosis is not a silicosis but a silicatosis, and he does not agree with Sparks (*RADIOLOGY*, 17, 1249, December, 1931) that in it "small calcareous nodules are scattered throughout the lower zone." The illustrations are well done and can be studied to advantage, although it must be remembered that without other corroborative proofs of the disease, the roentgenogram cannot be considered conclusive for diagnostic purposes.

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# ADENOIDS

Roentgen Therapy of Adenoid Tissues. Paul Gibert. *Jour. de radiol. et d'électrol.*, 22, 19-22, January, 1938.

Inflammation and hypertrophy of the adenoid tissues of the ring of Waldeyer play an important part in the pathology of infancy. Inflammation and hypertrophy are frequently components of a vicious circle. The effects are mechanical (obstructive) and infectious (local and distant).

The usual treatment is surgical ablation. Frequently this is unsuccessful, particularly if involvement is general throughout the nasopharynx. Often there is recurrence. There are many contra-indications to surgery—infection, youth of the patient, hemorrhagic syndromes, poor general condition, etc. In these cases, the extreme radiosensitivity of the adenoid tissues makes roentgen therapy efficacious and the method of choice. In addition, the favorable effect of roentgen therapy upon inflammatory conditions frequently renders this method of treatment preferable and available when surgery is contra-indicated. The author's technique: radiations of moderate or high penetration filtered through 10 mm. Al or 0.5 mm. Cu, F.S.D. 23 or 30 cm., fields covering the pharyngeal and cervical regions from the zygomatic arch to the clavicle. Doses of 100 r are given to each side two, three, or rarely four times, the series taking 15 to 21 days. The author believes this dosage may be too low. There is no danger, with these doses, of injury to normal tissues or of interference with growth.

S. R. BEATTY, M.D.

# APPARATUS

The Problem of the Filter Equivalent of the Wall of a Ray-proof X-ray Tube. H. Eschbach. *Strahlen-therapie*, 1938, 62, 287.

The author determined the filter equivalent of the wall of a Metalix deep therapy tube. He found that at 80 kv. it is equivalent to 3.2 mm. Al or 0.109 mm. Cu. At 180 kv., this changes to 4.25 mm. Al or 0.193 mm. Cu. The practical importance of these findings for the choice of the adequate treatment filter and the effect on the penetration of the radiation is discussed. It is recommended that manufacturers indicate not only the maximum potential and current for each tube but also the equivalent filter of the tube wall for a range of potentials.

ERNST A. POHLE, M.D., Ph.D.

A New Roentgen Therapy Tube for High Intensities with an External Anticathode Constructed by the "Compagnie Generale de Radiologie." J. Belot. *Bull. et Mém. Soc. de Radiol. Méd. de France*, 26, 153-158, March, 1938.

A new tube for therapy at 200 kv. has been designed, of which the chief feature of interest is the design of the

anode end. The cathode is conventionally placed in a glass tube which is sealed by a special collar at the anode end to a funnel-shaped tube of copper, the open, narrow end of which projects into the glass tube in line with the cathode ray. At the wide end of the copper tube, cut obliquely, is the tungsten anode, set into a heavy sheet of copper which has a spiral groove on the back for better oil circulation. The copper tube has a thinned-out area for a window. It is surrounded by a lead cylinder, for protection against radiation, which has an opening to correspond to the window. A heavy porcelain insulator holds the tube, with its attached oil tube and electrical connections, inside a metal shield of conventional design wherein circulates the oil for cooling. The high tension leads are conventional.

This design allows better cooling of the anode, lessens internal electrical strain, permits the use of heavy glass in the tube wall, and gives better protection from radiation.

At 200 kv. C.P., 18 ma., filtration total 1 mm. Cu + 2 mm. Al, 40 cm. F.S.D., 100 r per minute are obtained.

S. R. BEATTY, M.D.

Stereoscopic Roentgenograms. E. Hagenbach. *Schweiz. med. Wchnschr.*, 68, 598, 599, May 21, 1938.

A brief review of the uses of stereoscopy. The article is apparently intended to educate non-radiological practitioners to want this type of examination.

L. G. JACOBS, M.D.

The Amount of Off-focus Radiation in Beams from Various Types of Roentgen Tubes. R. Thoraeus. *Acta Radiol.*, 18, 753-760, October, 1937.

The off-focus radiation observed in seven different types of x-ray tubes varied from 9 per cent to 25 per cent. It is practically independent of tube voltage and filtration, very heavy filters excepted. The voltages employed in the experiments ranged from 60 kv. to 165 kv.

ERNST A. SCHMIDT, M.D.

Rotating Anode X-ray Tube. Robert A. Powers. *Calif. and West. Med.*, 48, 339-341, May, 1938.

An excellent description of a rotating anode tube is presented, bringing out clearly the advantages and disadvantages. The author concludes that the tube is a valuable addition to diagnostic x-ray equipment.

JAMES J. CLARK, M.D.

Modern Darkroom Illumination for Roentgen Laboratories. Fritz Luft and Martin Blütz. *Röntgenpraxis*, 10, 321-326, May, 1938.

The color of the darkroom light must be chosen in such a way that it appears as bright as possible to the eye and that it acts as little as possible on the photographic film. In order to determine this relationship quantitatively the spectral sensitivity of the eye for light and dark adaptation, and the spectral sensitivity

of the roentgen film were worked out. The best value and the best proportion for both were found. This value determines the color of the darkroom light.

The sensitivity of the eye for the different portions of the spectrum is dependent on the adaptation of the eye to light or dark. For an eye adapted to light the red-brown Agfa filter 104 is recommended; for an eye adapted to the dark the yellow-green Agfa filter 117.

The use of monochromatic light does not lead to an appreciable increase in efficiency.

HANS W. HEFKE, M.D.

The Measurement of Impedance in Edema. A. Denier. *Bull. et. mém. Soc. de Radiol. Méd. de France*, 8, 110-112, February, 1938.

The author describes briefly his modification of an apparatus for measurement of impedance. The capacity and the resistance must both be considered, as the measurement of resistance only is subject to many errors.

He distinguishes three groups as determined by his technic of measuring the local impedance:

In hypercholesteremia and venous stasis both capacity and resistance are increased.

In sodium retention and phospholipoid precipitation the capacity is increased and the resistance diminished.

In the third group the capacity and resistance are both diminished. In this group fall the obese, those with vasomotor disturbance, thyroid insufficiency, muscular hypotony, and alkalosis. In cancer these decreases are particularly notable.

S. R. BEATTY, M.D.

## BACKACHE

Low Back Pain with Sciatic Radiation: Recent Advances in Treatment. Maxwell Harbin. *Jour. Med. Assn. Ga.*, 27, 147-152, April, 1938.

Three causes of low back pain with sciatic radiation are discussed, namely, fibrositis, herniated intervertebral disk, and hypertrophied ligamentum flavum.

Fibrositis is diagnosed by exclusion and a careful history and physical examination. The roentgen examination is negative. There may be atrophy of the calf muscles and an absent Achilles' tendon reflex. Treatment is by the Ober operation of division of the ilio-tibial band or stripping of the fascia from the sacro-iliac joint.

Herniated intervertebral disks are found to be a more frequent cause of pain than has been suspected. Ninety per cent of the ruptured disks are found in the low lumbar region. Patients are usually healthy, vigorous men who complain of back pain of long standing following an injury or strain. Pain radiates down the thigh and calf. Various neurologic symptoms may be found, the most common being a decreased ankle reflex. Sensory impairment is rare. Pain is only temporarily relieved by the usual measures. If the spinal fluid total protein is elevated above 40 mg. per cent it is believed necessary to put iodized oil in the spinal canal and make serial films in various projections. The

defect in the oil shadow occurs at the intervertebral space and may be partial or incomplete. The herniated fibrocartilage is removed by laminectomy.

Hypertrophy of the ligamentum flavum produces much the same clinical symptoms and the same type of filling defect on the x-ray films. The ligament is composed of yellow, elastic tissue and repairs trauma with fibrous connective tissue. There may be an overgrowth of repair tissue, with resultant pressure on the emergent nerve root, the dura or cauda equina. Treatment is by surgical removal after laminectomy.

J. E. WHITELEATHER, M.D.

Differential Diagnosis of Pain Low in the Back: Allocation of the Source of Pain by the Procaine Hydrochloride Method. Arthur Steindler in collaboration with J. V. Luck. *Jour. Am. Med. Assn.*, 110, 106-112, Jan. 8, 1938.

The authors approach the problem of allocation of pain by following the routes of sensory supply to the tissues of the lumbosacral region. The posterior division of the lumbosacral portion of the spinal nerve supplies the long muscles of the back (sacrospinalis), all the posterior ligamentous structures, the aponeuroses and periosteal attachments, a portion of the gluteal fascia, the lumbodorsal sheath, the supraspinous and interspinous ligaments, the superficial and the deeper ilio-sacral ligaments, the sacro-ischial ligaments, and in part the iliolumbar ligament, the intervertebral articulations, and the sacro-iliac articulations. Irritations are apt to produce either sharply localized superficial pressure points at ligamentous and aponeurotic attachments or more diffuse areas of tenderness in muscles and sheaths. These localized peripheral lesions are capable of producing radiation not only in the posterior but in the anterior division along many different pathways. Furthermore, they produce postural anomalies the same as those produced by irritation of the nerves of the anterior division.

The pathways of the anterior division do not involve the immediate problem. Probably more cases are of purely reflex origin and not due to direct compression in the intervertebral canal than is generally accepted.

One would expect a large portion of cases of low back pain to belong to the posterior syndrome group. This division, comprising the long muscles of the back, their aponeuroses and periosteal insertions, and their muscle sheaths and superficial ligaments, forms one physiologic unit. Tension is transmitted to the whole system either by contracture of the muscles of the back (forward flexion test) or by stretching of the hamstrings (Lasègue's sign) and it is significant that this sign is negative in cases of true neuritis and in tumor of the cord, and positive in cases of fibrositis and myofascitis of the muscles of the back. The pain involves the nearest structure put under strain in cases of trauma, and the first one to give under continued stress in the postural and degenerative group.

There is a syndrome involving the deep posterior division, that is, the deeper ligamentous structures of the sacro-iliac junction, the iliolumbar ligament, and also the transverse sacral process in cases of sacraliza-



tion. These structures are supplied totally or in part by the posterior division of the lumbosacral region. Signs are found indispensable both for the superficial and for the deeper local lesion in the territory of the posterior division.

Recognizing that local tenderness, radiation, and faulty posture must apply for the posterior as well as for the anterior division syndrome, the authors attempted to single out those cases in which a definite localized source of pain was found by palpation, and in which the leg signs consistently referred to this localized tender point. The structures involved were all supplied by the posterior division of the spinal nerves. They next tried to establish the relation of this local point to radiation.

The test was made by injecting into the area of local tenderness from 5 to 10 c.c. of a 1 per cent solution of procaine hydrochloride. The involved tissue was identified by a definite sensation of pain when the point of a deeply inserted needle came in contact with it. Contact with the needle aggravated the local pain, elicited or aggravated radiation. The procaine hydrochloride infiltration suppressed local tenderness and radiation and the positive leg signs disappeared. When all these requirements were met, the patient was considered as reacting positively to the test, and the radiation was a reflex phenomenon elicited by the local lesion.

Conservative treatment by immobilization and physical therapy was most successful in patients reacting positively.

CHARLES G. SUTHERLAND, M.D.

## BONE DISEASES (DIAGNOSIS)

Changes Simulating Legg-Perthes' Disease (Osteochondritis Deformans Juvenilis) Due to Juvenile Myxedema: Report of a Case. Fuller Albright. *Jour. Bone and Joint Surg.*, 20, 764-769, July, 1938.

This is a case report of an instance of coxa plana developing in a child with hypothyroidism, with eventual reformation of the femoral head after adequate thyroid therapy. The condition is to be differentiated from true Legg-Perthes' disease.

J. B. McANENY, M.D.

Familial Disseminated Osteosclerosis. K. F. B. Busch. *Acta Radiol.*, 18, 693-714, October, 1937.

The author studied 15 cases of familial disseminated osteosclerosis, 14 of which occurred in one family, distributed over three generations. The bone changes can be visualized roentgenologically from the second to the third year of age. Six of the patients showed skin alterations which are commonly described in the dermatologic literature as "disseminated lenticular dermatofibrosis." The author believes that disseminated osteosclerosis is unrelated to the so-called "compact tissue islands," as is claimed by some investigators. He also declines the theories assuming

either an infectious or an endocrine etiology for the condition which he simply considers "a benign, familial, constitutional, anomaly," localized in the skeleton and occasionally in the skin.

ERNST A. SCHMIDT, M.D.

Ossification of the Internal Paracondyle of the Femur (Pellegrini's Disease). Carlo Guarini. *Archivio di Radiologia*, 16, 431-446, September-December, 1937.

Guarini here reports 13 cases found in 3,500 patients examined roentgenologically after trauma in two years. The ossifications were of varying size, shape, and consistency but the author never demonstrated osseous trabeculation in them. In all cases the outline of the condyle was sharp. In this series of cases, involvement of the right knee occurred ten times. Guarini has found Marçoni-therapy of value in treatment. The author cites an extensive list of references.

E. T. LEDDY, M.D.

Larsen-Johansson's Disease of the Patella and Schlatter's Disease. E. Glanzmann. *Schweiz. med. Wchnschr.*, 68, 494-497, April 30, 1938.

The author reports the case of a girl, referred for a minor trauma, who was found to have a left-sided bipartite patella, the upper lobe of which had undergone an aseptic necrosis of the Sinding Larsen type. Her cousin had a bilateral Schlatter's disease, and her uncle, a bilateral exostosis of the adductor tubercle. The factors in the development are discussed at some length. The author believes that both these conditions, Perthes' disease, both Köhler's diseases, and spinal osteochondritis are related. The existence of anomalous ossification centers is predisposing to an aseptic necrosis. The condition is often familial, showing an ill-defined dominance, and alternation of exostoses and aseptic necroses may be observed.

L. G. JACOBS, M.D.

## CALCINOSIS

Calcinosis Cutis. M. E. Pusitz, A. K. Owen, and G. A. Finney. *Jour. Am. Med. Assn.*, 110, 360-363, Jan. 29, 1938.

Calcinosis cutis is defined as a pathologic state in which calcium deposits are laid down in the skin and subcutaneous tissues. As such, it must be differentiated from myositis ossificans, calcification of hematomas, calcified tumors, phleboliths, atheromas, calcified tubercles, or calcified lesions due to parasites such as *Trichinella*, the calcification in cysts, or even production of osteomas in the skin. With these pathologic states left out of consideration, one has left two main syndromes, one which is not connected (supposedly) with parathyroid activity, which has been termed idiopathic calcinosis cutis, and the other, which may be accompanied by definite evidence of hyperparathyroidism even if no adenoma may be clinically or surgically discovered. The authors prefer to classify the latter

among the cases of idiopathic calcinosis rather than as examples of hyperparathyroidism. Calcification associated with scleroderma, dermatomyositis, Raynaud's disease, or local arteriosclerosis appears to be due to local conditions.

The causation is unknown. Since the majority of patients are females, an attempt has been made to involve endocrine disturbance. The widespread nature of the condition at once rules out trauma as a definite factor. Calcification following a degenerative process affecting the fat lobules was suggested, but it has been shown that such necrosis does not occur in the fat cells.

In calcareous infiltration there is a deposition either in the cells or in the intercellular substance of larger and smaller granules, composed chiefly of calcium phosphate and carbonate. Normal skin does contain a small amount of calcium, but this is not sufficient to be noted under the microscope. When the collection of these granules becomes abundant enough there is a hardness, a brittleness, and a whitish appearance of the affected tissue. Under the microscope they appear dark by transmitted and white and glistening by reflected light. These pathologic calcifications are retained, not in the diffuse state in which they exist in bone, but in particles or clumps. The calcium compounds, however, are the same in both normal and pathologic states. Initial histopathologic change in cutaneous calcinosis consists of a deposition of fine granules of calcium salts around apparently normal fat cells in the subcutaneous tissue. This is not accompanied by necrosis or acute inflammatory change.

The routine examination of the blood, the urine, and the stool does not yield pathologic data.

CHARLES G. SUTHERLAND, M.D.

## CANCER (DIAGNOSIS)

The Direct Demonstration of Bronchial Stenosis in Bronchial Carcinoma. Heinrich Eschbach. *Röntgenpraxis*, 10, 294-303, May, 1938.

Three methods are of great importance for the diagnosis of bronchial carcinoma; roentgen examination, bronchography, and bronchoscopy. The direct demonstration of the bronchostenosis without the use of contrast material has been described only by Lenck. The demonstration of these cancers is usually possible by a Bucky film, because they are commonly situated close to the bifurcation and within the hilar shadows, which makes a good contrast of the air in the trachea and the main bronchi possible. The examination must be done in deep inspiration and in horizontal position by means of the Bucky, usually best in postero-anterior direction of the rays.

By means of films and diagrams the author proves his contention that a direct visualization of the stenosis in the bronchus is possible in many cases, when the technic is correct. One cannot succeed in all cases; kyphosis, adipositas, and widening of the aorta for instance are factors which might make such a demonstration impossible. Parenchymatous tumors of the lungs or tumors originating in a small bronchus will of

course not allow the x-ray diagnosis of a stenosing lesion in a bronchus.

The author believes that the roentgen diagnosis of cancer of the bronchus is made much more reliable when this method is added. If the findings are positive he believes bronchography and bronchoscopy may be omitted in certain cases when such rather strenuous types of examination are too severe for the patient.

HANS W. HEFKE, M.D.

The Geneva Classification of Carcinomas of the Collum Uteri. J. Ducuing. *Acta Radiol.*, 19, 13-22, March, 1938.

Pointing out the difficulties inherent to any attempts at medical classification, the author discusses the classification of cancers of the uterine collum as adopted in 1929 by the "Radiological Sub-commission of Cancer" of the League of Nations. In this classification the author criticizes: (1) certain negative definitions, e.g., the attribution to Stage III of all cases not to be referred to Stages II or IV; (2) the conception of mobility, difficult to define and uncertain with regard to cause (infection or tumor); (3) certain defects in the subdivision of the different stages, e.g., cancers with adenopathies and discontinuous propagation being placed in Stage III instead of Stage IV (according to Ducuing); (4) the lack of precision in the definition of certain cases in certain stages, the author considering it necessary to specify further, e.g., to say Stage III (vagina) or Stage III (parametrium), and similar.

For cancers which escape definite classification under this system, rubrication in a column of "remarks" or "special cases" is suggested.

ERNST A. SCHMIDT, M.D.

Pseudo-esophageal Type of Cancer of the Bronchus. Rebattu, Gravier, and Sprecher. *Jour. de méd. de Lyon*, 18, 459-461, Aug. 20, 1937.

A case presenting first recurrent paralysis and latter symptoms and roentgenologic evidences of esophageal carcinoma was proven by bronchoscopy and biopsy to have bronchogenic cancer. In all mediastinal syndromes, endoscopy should be performed as the roentgenologic findings are not always conclusive.

S. R. BEATTY, M.D.

Appearance of a Lesion in October, 1937, in a Patient Observed since October, 1930, because of a Gastritis Syndrome: Radiologic Signs and Surgical Verification. Maurice Delort. *Arch. d. mal. de l'app. digestif*, 28, 159-164, February, 1938.

A patient who had been observed clinically for seven years because of gastritis with hypo-acidity and achlorhydria, developed suddenly an attack of vertigo and abdominal pain followed by loss of appetite. Roentgenologic examination demonstrated a small lesion of the greater curvature which microscopically was a scirrhous carcinoma.

S. R. BEATTY, M.D.

## CANCER (THERAPY)

Six-year End-results in the Treatment of Uterine Carcinoma in the St. George General Hospital in Hamburg. A. Hamann and A. Göbel. *Strahlentherapie*, 1938, 62, 251.

Four hundred seventy-six cases of gynecological carcinoma treated from June, 1929, to December, 1931, at Holthusen's institute in Hamburg are statistically analyzed by the authors. Of these cases, 379 had carcinoma of the cervix and 34 of the fundus. The majority of the cervical cancers (63.2 per cent) were treated radiologically. Twenty per cent were free from symptoms after five years and 19 per cent after six years. In the group with carcinoma of the fundus, approximately equal numbers were treated by radiation only and by a combination of surgery and irradiation. The five- and six-year cures were 21.6 and 20.1 per cent, respectively. An analysis of the treatment methods used shows that the protracted fractional dose method is not superior to simple fractionation as far as the end-result is concerned. However, the patients tolerated the protracted fractional doses better, there were fewer late skin reactions, and fewer intestinal disturbances.

ERNST A. POHLE, M.D., Ph.D.

Palliation of Cancer in Gynecology. Frank R. Smith. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 866-870, June, 1938.

The author states that the majority of the gynecological carcinoma cases presenting themselves to cancer institutions are patients with advanced disease. Palliative care is given to relieve such symptoms as pain, hemorrhage, and obnoxious discharge. The palliative treatment includes administration of drugs for relief of pain, cauterization for control of hemorrhage, and removal of bulky tumors and irradiation for control of infection. Vaginal fistulae are in most cases a manifestation of advanced disease and when they occur after radiation therapy they should not be repaired until the patient has remained free from disease for five years. Several illustrative case reports are given.

IRVING I. COWAN, M.D.

## CONTRAST MEDIA

The Basis, Limits, and Toleration of Endobronchial Iodized Oil. Günther Anton. *München. med. Wehnschr.*, 85, 919-923, June 17, 1938.

The tolerance of a lung for an endobronchially injected medium is dependent on the age of the patient and the pulmonary or general disease concerned. Circular lesions of the ciliated epithelium of the bronchi tie up the removal of the oil by way of the trachea. The roentgenologically demonstrated damage to the lung, as, for example, a lung carcinoma leads to a delayed elimination of the endobronchially administered oil, apparently through injury to the alveolar epithelium.

Iodols and not iodized oils can cause allergic reactions endobronchially. Fractional filling in bronchiectasis in selected cases will have no after-effects if the tolerance of the lung at subsequent fillings is not overstepped.

L. G. JACOBS, M.D.

Lipiodol Emboli in the Brain and Lungs after Hysterosalpingography. G. Hemmeler. *Schweiz. med. Wehnschr.*, 68, 717-719, June 18, 1938.

The author reports a case in which, following a hysterosalpingography for sterility, severe symptoms, both physical and mental, ensued. Roentgenograms showed flow of the lipiodol into the uterine plexus, and a film of the lungs two days later showed evidence of fat embolus. The patient recovered rapidly without sequelae. The author comments on the rarity of reports of this accident in the literature.

L. G. JACOBS, M.D.

## DIVERTICULITIS

Diverticulitis. Edwin A. Nixon. *Northwest Med.*, 37, 97-100, April, 1938.

The essayist states that the commonest lesions found in the colon are diverticula and their sequelae, and that the surgical treatment of these lesions consists primarily in treating their complications.

A description of the origin of the word "diverticulum" and its etiology follows. Quoting from Willard and Bockus, the writer gives the following clinical findings: 87 per cent of the patients had pain in the left lower abdomen; 39 per cent, bleeding from the bowels; 37 per cent had rise of temperature; 35 per cent had constipation, and 15 per cent had diarrhea. Bladder symptoms were found in 50 per cent of the patients suffering from diverticulitis.

It has been only recently that the profession has become diverticulitis-conscious. Twenty years ago it was considered a pathologic curiosity.

Sigmoidoscopic examination seldom reveals the lesion. Roentgen examination offers a more satisfactory method to detect and determine the number of diverticula. The method given is the one used by the radiologists of the Naval Hospital at Bremerton. The patient is given one ounce of mineral oil, and one drachm of fluid extract of cascara the night before examination. At 8:00 A.M. soap suds enema and one hour later plain water is used for colonic flushing until the water returns clear. An enema consisting of one pound of barium, four ounces of powdered acacia, and three quarts of water is given under fluoroscopic control, using forceful manipulation to thoroughly spread the mixture. Two films are made; one before evacuation of the enema, and the other, a contrast enema, after air has been injected under fluoroscopic control.

The author arrived at the following conclusions:

1. Diverticula and their sequelae are the commonest lesions to be found in the colon.

2. Age and constipation cause these lesions to form through weakened musculature in the aneimesenteric border of the colon, and into the epiploic appendages.

3. Roentgenologic examination by the combined barium enema and air injection offers greater opportunities for studying the numbers and locations of the diverticula.

A. MAYORAL, M.D.

## FOREIGN BODIES

The Exact Localization of Marginal Intra-ocular Foreign Bodies. H. Goldmann. Schweiz. med. Wchnschr., 68, 497, 498, April 30, 1938.

After discussing briefly the methods of localizing foreign bodies in the eye, the author advocates a "bone-free" or intra-orbital film technic, in which a small metal ring is placed on the globe in a plane perpendicular to the beam, and adjusted till the foreign body lies in the center of the ring shadow. This gives a very precise localization for surgical intervention.

L. G. JACOBS, M.D.

New Procedure for Localization of Foreign Bodies in the Eye. P. Cottenot. Bull. et mém. Soc. de Radiol. Méd. de France, 8, 89, 90, February, 1938.

The author describes his technic of foreign body localization in the eye, using his modification of the serioscope and two films taken with a tube shift toward the feet. A special contact lens with lead markers is necessary.

S. R. BEATTY, M.D.

## GASTRO-INTESTINAL TRACT (DIAGNOSIS)

What Kind of Roentgen Examination of the Digestive Organs can the General Practitioner Commend? W. Kaufmann. München. med. Wchnschr., 85, 625-629, April 29, 1938.

A very general review of the method and technic as well as the diagnostic points of gastro-intestinal roentgenography.

L. G. JACOBS, M.D.

Hepato-diaphragmatic Interposition of Loops of Small Intestine and its Relationship to Other Affections (Gastrectasia, Pneumatosis Cystica, etc.). Aldo Piergrossi. Archivio di Radiologia, 16, 410-429, September-December, 1937.

Piergrossi, of Naples, describes the pathogenesis of this lesion, first described by Béchère in 1899, and illustrates the roentgenologic findings associated with it. In the majority of instances the lesion is associated with some other gastro-intestinal abnormality such as dilatation and atony of the stomach, gastric or duodenal ulcer, adhesions, pneumatosis cystica, etc. The author feels that traction between the stomach and liver, together with other co-existing conditions, causes the

interposition. The article is accompanied by a good bibliography.

E. T. LEDDY, M.D.

## HEART AND VASCULAR SYSTEM

Intra-arterial and Intra-cardiac (Left Ventricle) Injections. Carlos Burgos. Annaes Paulistas de Medicina e Cirurgia, 35, 217-223, March, 1938.

The author admits that intra-arterial injections are not new, and reports excellent results in 16 cases in which they were used in cases of infections in the extremities. He feels that many limbs were saved by the procedure. The medical agent used is named in the text.

He also reports a case of tetanus in which the serum was injected into the left ventricle, with the patient under chloroform anesthesia. Not even alteration of the pulse was caused. The patient recovered.

A. MAYORAL, M.D.

Roentgen Kymographic Study of the Heart. G. M. Tice. Jour. Kansas Med. Soc., 39, 198-201, May, 1938.

The literature on this subject is reviewed briefly, together with details on the construction of apparatus. The appearance of the normal kymogram has not been definitely established and when this is done the value of the method will become definitely greater. The author has not found the kymogram particularly valuable in the differential diagnosis of aneurysm and mediastinal tumor. It does record the movements of the various segments of the cardiac borders but the findings may be difficult of interpretation. Myocardial damage often shows characteristic changes in the wave form. Irregularities in rhythm can be detected. The kymographic findings should be correlated with the other clinical and laboratory data to obtain the most value from the examination.

LESTER W. PAUL, M.D.

## HERNIA

Diaphragmatic Hernia. Joseph C. Root and Clark P. Prickett. Cleveland Clinic Quarterly, 5, 203-216, July, 1938.

The authors found 31 diaphragmatic hernias in 2,213 routine gastro-intestinal series. The different types are classified as: (1) thoracic stomach; (2) diaphragmatic hernia with short esophagus; (3) hiatus hernia—esophagus of normal length; (4) congenital hernia; (5) traumatic hernia; (6) congenital absence of diaphragm.

Each type of hernia is defined and discussed as to origin and appearance on x-ray examination. Reproductions of illustrative films are presented. Symptomatology, physical findings, diagnosis, and treatment are sketched.

J. B. McANENY, M.D.

## INFLAMMATORY DISEASES

Optimum Effective Doses in Roentgen Therapy of Inflammatory Affections. Gaston Daniel. Bull. et mém. Soc. de Radiol. Méd. de France, 26, 55-65, January, 1938.

The author discusses the technic of roentgen therapy in inflammatory conditions, and, in particular, his use of very small doses. In acute conditions he employs 25-28 kv. effective, 4 ma., 35-40 cm. F.S.D., no filter or 1 cm. of leather for superficial infections and no filter up to 4 mm. Al in more deep-seated processes. Superficial infections receive from 1 r to 3 r; deep infections, as of the pelvis, 0.01 r to 1 r (effective in the tissues) at each sitting, repeated as necessary at from three- to five-day intervals. In chronic infections five or six doses of about 10 r on the skin are given in five minutes with 25 kv. effective, 4 ma., 35 cm. F.S.D., employing filtrations of 0.05 mm. Al.

To render a chronic lesion acute, vaccines are frequently injected after preliminary irradiation of the involved area, the area of vaccination is treated at the stage of maximum reaction and from four to six hours later the lesion is again treated. Another dose may be given after 12 hours but is seldom necessary.

The effect of such doses is limited to the infectious process. The sympathetic nervous system requires much larger doses before it is affected.

In 67 cases of acute and subacute infections of various types, the author reports 66 cures, with benefit in the remaining case, one of anthrax in which larger doses and incision were necessary. Parallel results were observed in chronic infections.

S. R. BEATTY, M.D.

Indications, Technic, and Results of Radiotherapy of Inflammatory Conditions of the Tonsils and Nasopharynx. André Meyer. Bull. et mém. Soc. de Radiol. Méd. de France, 26, 48-52, January, 1938.

The author reviews a number of articles dealing with the use of roentgen therapy in inflammatory conditions of the nose and throat, and reviews his own experiences in a small series of cases (27).

Roentgen therapy offers an effective, safe, and painless means of therapy in the following conditions:

1. Acute inflammation—acute angina (dose 50-100 r).
2. Chronic inflammations, chronic tonsillitis, recurrent angina, chronic pharyngitis with metastatic focal infections (dose up to 2,500 r).
3. Diphtheria carriers, chronic streptococcic throat infections (500-1,000 r).
4. Certain forms of tonsillar hypertrophy and hypertrophy of the nasopharyngeal lymphoid tissues (dose 1,000 r-4,000 r).
  - (A) With surgical contra-indications, as hemophilia, cardiac, pulmonary, renal disease, etc.
  - (B) Recurrences after surgery.
  - (C) Forms difficult for surgical treatment as lingual

tonsils, diffuse hypertrophy, etc. Simple tonsillar hypertrophy should be treated surgically.

The author's technic: 200 kv., 30 cm., F.S.D., 1 mm. Cu to 1.5 mm. Cu plus 2 mm. Al filtration with fields 4.8 cm. diameter over each tonsillar area. Two or three treatments a week, of from 200 r to 400 r are given, to each side alternately. The more acute the condition the smaller the dose.

The results of roentgen therapy are such that in the above conditions it should be considered the method of choice.

S. R. BEATTY, M.D.

Radiation Therapy in Benign and Malignant Diseases of the Ear, Nose, and Throat. H. W. Hefke. Wis. Med. Jour., 37, 551-554, July, 1938.

There are many diseases involving the ears, nose, and throat which are amenable to or, are palliated by, radiation therapy. Among the conditions listed by the author are the following: inflammatory diseases of the nose and throat, acute and subacute cervical adenitis, septic and post-operative parotitis, phlegmons about the face and mouth, furuncles and carbuncles, keloids, hemangiomas. In all of the malignant diseases in this area radiation therapy has some place and in many of them it is the method of choice. No detailed technical methods are given but some of the more recent advances, especially the Coutard technic, are discussed.

LESTER W. PAUL, M.D.

## THE KIDNEYS

Studies on the Pathology of the Renal Papilla. Alexander Randall, John E. Eiman, and Paul R. Leberman. Jour. Am. Med. Assn., 109, 1698-1702, Nov. 20, 1937.

A primary renal calculus must be stationary and attached while beginning and acquiring growth; small renal calculi almost always show such a stoma, or facet, of mural attachment. X-ray studies in proper cases repeatedly showed that primary renal calculi have their origin in the minor calices. In a series of postmortem investigations a new pathologic lesion of the renal papilla was observed, consisting of a deposit of calcium in the basement membrane of the collecting tubules and in the intertubular connective tissue. Such deposits, or calcium plaques, while intrapapillary were innocent of further harm, but when they occurred near the surface of the papillary wall they were prone to lose their surface covering of epithelium and when so denuded, could and did act as the nidus on which the salts in the caliceal urine were deposited, and a stone was formed. These calcium plaques proved on chemical analysis to consist of calcium carbonate, calcium phosphate, and perhaps calcium nucleinate. By chemical analysis pure calcium phosphate calculi and pure calcium oxalate calculi were proved thus to grow in man.

In experimental reproduction of these lesions the introduction of bacteria *per se* was not essential to the

problem. As the lesion gave every evidence of being a calcium deposition in response to some form of damage to the collecting tubules, there was the possibility that the concentration of some toxic material at this point could be the primary cause. Experiments seemed definitely to prove that the kidney can and does concentrate this toxic material from two and a half to 60 times the blood stream content. The elimination of a streptococcus toxin through the kidney can cause definite localized damage, which is most marked in the walls of the collecting tubules. Efforts to reproduce this calcium plaque formation in lower animals by vitamin-deficient diets failed. After the administration of parathyroid extract to dogs for six months a calcium plaque was observed identical to that seen in man in one renal papilla.

The occurrence of renal calculus in man is essentially only a symptom of some underlying pathologic condition of a renal papilla. Its entire development in experiments chronic process. Acute results obtained in experiments on animals are not comparable to the clinical picture.

CHARLES G. SUTHERLAND, M.D.

Roentgenological Examination of the Kidney, with Special Reference to Backflow and Injuries Associated with Retrograde Pyelography. William E. Stevens. *Jour. Urol.*, 39, 598-610, May, 1938.

Excretory urography alone is sufficient for an accurate or complete diagnosis in a limited number of cases. During retrograde pyelography the renal pelvis may be perforated by a ureteral catheter or bougie or ruptured by excessive pressure during injection of the pyelographic medium. Chemical necrosis may also perforate the pelvis. The author believes it is impossible to perforate a normal kidney pelvis in an adult with an ordinary catheter or bougie. Extreme gentleness should be employed in catheterization and injection of the renal pelvis in infants and young children.

Injury to the kidney and backflow are not uncommon during retrograde pyelography; the principal danger of such happenings lies in the dissemination of infectious material. Rupture extending through the capsule of the kidney is the most dangerous complication associated with retrograde pyelography.

The author presents 23 cases demonstrating perforation of the renal pelvis, lymphatic backflow, pyelovenous backflow, and tubular backflow.

JOHN G. MENVILLE, M.D.

## THE LUNGS

The Evolution of the Parenchymal Lung Lesions in Rheumatic Fever and Their Relationship to Mitral Stenosis and Passive Congestion. Benjamin Gouley. *Am. Jour. Med. Sci.*, 196, 1-10, July, 1938.

The pulmonary changes in rheumatic fever cannot be accounted for wholly on the basis of congestive failure or mitral stenosis, since both factors may be

absent or developed to a varying degree. They are in part due to the parenchymal disease which occurs during the generalized infection.

The rheumatic pneumonopathy can be identified as an interstitial hematogenous inflammation, characterized, in the acute stage, by monocyte invasion and fibrinoid necrosis, which are later replaced by multinucleated basophilic cells, the "Aschoff" cells. Still later there is an invasion by plasma cells, lymphocytes, and fibroblasts. In some cases Aschoff nodules may be found. An important feature is the destruction of the elastica.

Marked changes in the consistency of the lung tissue and occasional basal atelectasis, which is probably due to the loss of elastica, feature the subacute stage.

In the chronic stage, the lung is "rubberoid" in consistency, and microscopically shows a patchy interstitial pneumonitis with marked hyperplasia of the elastica. This latter, called "elastosis" by the author, is not pathognomonic of a rheumatic infection. The arteritis and arteriosclerosis are of secondary importance in the development and evolution of the rheumatic lung disease.

BENJAMIN COLEMAN, M.D.

Thoracoplasty with Extrafascial Apicolysis. C. Semb. *British Med. Jour.*, 650-656, Oct. 2, 1937.

The author's method satisfies the three requirements for thoracoplasty: (1) it causes a complete collapse of the cavity; (2) it causes a selective collapse of the cavity; (3) the operative risk is small. This method is characterized by three chief points: (1) apicolysis in the extrafascial plane by cutting the so-called suspension bands of the lungs sharply or bluntly; (2) a radical rib resection according to the extent of the apicolysis or more; (3) preparation of an extrafascial space by cutting periosteum of ribs in such a manner that they are not loosened from the surface of the lung cone. The result of the third stage is such that the periosteum-bearing tissue collapses with that portion of the lung containing the cavity, and later, when osseous tissue is formed by the periosteum, it forms in such a fashion as to contact and support the lung in its new position. The operation is done in several stages. The mortality is less than 3 per cent. The collapse of the cavity has been selective in 14 out of 16 patients who had been operated on by other methods without success.

W. H. GILLENTE, M.D.

Solitary Congenital Pulmonary Cyst: Report of One Case. Paul C. Gunby. *Western Jour. Surg., Obst., and Gynec.*, 46, 321-324, June, 1938.

The patient was admitted to the Out-patient Department of the Children's Hospital in Seattle, in June, 1935, with a history of a draining empyema sinus of two years' standing; a complication of a typical attack of left bronchial pneumonia. At the time of study the

patient had had numerous drainages of the chest with removal of portions of the ninth, tenth, and eleventh ribs, posteriorly. Drainage from the cavity was of a mucoid character. The clinical condition of the patient was good. A diagnosis of solitary congenital cyst was suspected and the entire lining of this cavity was removed and the wound closed with drainage. The cyst replaced the entire lower lobe and measured nine centimeters in diameter with walls varying between one and 12 millimeters.

Attention is called to an article describing similar cases by Dr. Eloesser, published in 1931. The pathology of the condition is discussed. The cysts, when solitary, are symptomless unless infection occurs. The walls are characteristically trabeculated and clean, and a glary mucoid discharge is found.

W. H. GILLETINE, M.D.

## MAXILLARY FRACTURES

Kirschner Traction in the Treatment of Maxillary Fractures. Glenn Major. *Jour. Am. Med. Assn.*, 110, 1252-1254, April 16, 1938.

A high percentage of fractures of the upper jaw are complicated by fracture of the skull through the anterior cranial fossa. Most of these fractures are compound, projecting through the nose, and nasal drainage of cerebrospinal fluid is usually present. Obviously, the first consideration is the possibility of injury to the brain, due either to laceration or to hemorrhage, and the second consideration is the potentiality of intracranial infection in the nature of meningitis, sinus thrombosis, or abscess of the brain. The patient should be treated conservatively for a week at least, the treatment being that ordinarily employed for fracture of the skull. In addition, the maxilla should be immobilized as completely as is possible with a head-chin bandage, a procedure which is grossly inadequate at best. The nose should be sprayed at frequent intervals; the author uses tincture of merthiolate. If the fracture is accompanied by injury to the facial attachments of the ligament or by laceration of the ligament itself, diplopia often results. It is then imperative that the fragments be reduced accurately, so that the two eyeballs are brought to the same normal horizontal level.

Rarely does a fracture of the maxilla occur in which the fracture line does not involve one of the maxillary frontal or ethmoid sinuses. Marked sinus infection after such an injury is the exception rather than the rule. Tardiness of union of the bone is a feature worthy of note. All splints may be removed at the end of from three to five weeks, but as a general rule several more weeks, or sometimes months, must elapse before complete firm union has resulted. Union is usually prompt in fractures of the maxilla. Osteomyelitis is uncommon in the maxilla and occurs in the mandible in from 5 to 10 per cent of cases.

The author describes a method for the gradual reduction of horizontal fractures of the maxilla, based on the principles of skeletal traction and involving a

Kirschner wire. This effects gradual and complete reduction of these fractures, and tremendous force may be exerted, if desired, with practically no discomfort to the patient. The apparatus can easily be applied with the patient under local anesthesia, and there is little possibility of additional intracranial injury or infection, because of the gradual reduction.

CHARLES G. SUTHERLAND, M.D.

## PROTECTION

Secondary Radiation from Protective Walls in Hard Roentgen Radiation. Ragnar Bernstedt. *Acta Radiol.*, 19, 85-101, March, 1938.

Of the commonly used building and protective materials, lead showed the smallest amount of secondary radiation. Only barite tiles offered comparable protection. It is interesting to note that, for protection against voltages used in diagnostic rooms, the secondary radiation was smallest when the lead was placed on the far side of the wall from the tube, while, according to the author, placing of the lead on the tube side of the room was slightly more advantageous when therapeutic voltages were used.

ERNST A. SCHMIDT, M.D.

## SARCOMA

Osteolytic Osteogenic Sarcoma, with a Report of Eight Five-year Survivals. I. S. McReynolds. *Surg., Gynec. and Obst.*, 67, 163-168, August, 1938.

Ninety-nine of a series of 131 cases of osteolytic sarcoma were followed for five years, at which time eight were surviving. These lived from six to ten years longer. Ninety-two per cent of all cases died within the five-year period, the average duration of life being 10.3 months after the primary treatment. Primary amputation well above the location of the tumor, or radical resection where possible, are considered the treatments of choice. Roentgen-ray therapy is considered palliative for pulmonary metastases. The general subject is concisely reviewed and the eight cases are presented in detail.

W. R. BROOKSHER, M.D.

## SKIN DISEASES

Clinical Management of Skin Cancer. Eric Liljencrantz and George V. Kulchar. *Calif. and West. Med.*, 49, 30-36, July, 1938.

The authors have presented a very excellent paper covering their method of diagnosis, treatment, and management of skin cancer. They emphasize the importance of a biopsy as an aid in correct treatment, and discuss treatment from a surgical and irradiation viewpoint. Their studies indicate that the failures to cure are frequently due to either inadequate surgery or ir-

radiation. They discuss the quality of radiation and clearly explain what may be expected from either soft or hard rays. They indicate a preference for x-ray over radium. They emphasize the importance of a proper follow-up system, and the frequent examination of the patient which, if carefully done, will naturally improve the results.

In their conclusions they state that accurate diagnosis is essential, that distinction must be made between rodent and epidermoid carcinoma, that skill and thoroughness are required, and that a conscientious follow-up is of greatest importance.

JAMES J. CLARK, M.D.

Lupus Vulgaris and the Significance of Certain Non-specific Eruptions in Relationship to Tuberculosis. J. E. McGlashan. *Med. Jour. Australia*, 1, 607-611, April 2, 1938.

The author discusses the specific tuberculous skin lesions, the cutaneous tuberculides (Darier), and the hypodermic tuberculides with regard to their bacteriology, histology and microscopic structure, etiology, and results of animal inoculation. He considers the evidence relating the so-called non-specific lesions to tuberculosis, the information being grouped under the above subheads. The amount of information given in this short article is such that no succinct detailed abstract is possible.

W. H. GILLENTE, M.D.

Herpes and Physiotherapy. Serret. *Bull. et mém. Soc. de Radiol. Méd. de France*, 25, 773-775, November, 1937.

The sufferer from herpes is too frequently sent to the radiotherapist late in the course of the disease, and radiotherapy in this stage is usually unsuccessful. In the earlier stages of the disease, it is more amenable to radiotherapy. The author cites six cases of his own cured by ultra-violet irradiation in heavy doses. Roentgen therapy has proved equally successful in the hands of others. These cases should be treated in the first 48 hours.

S. R. BEATTY, M.D.

## THE STOMACH

Complete Removal of the Stomach for Malignancy: Report of Five Surgically Successful Cases. Frank H. Lahey. *Surg., Gynec. and Obst.*, 67, 213-223, August, 1938.

The author presents five surgically successful cases of total gastrectomy with full technical details. One patient lived three and one-half years, one has lived nearly a year without evidence of recurrence, one has been but recently operated upon, and two lived six and nine months, respectively. It is felt that the procedure will be occasionally justifiable after the lesion is exposed, its extent determined, and visual metastasis not observed. There are two distinct types of

carcinomatous involvement of the stomach. In one, the more common type, the lesion is local, with early and extensive metastatic involvement of the adjacent lymph nodes, usually seen late in its course, and with a discouraging percentage of cures. In the other, the lesion is not local but one in which the growth appears thoroughly to have infiltrated the gastric walls without, however, apparent metastatic lymph node involvement. It is in this type that total gastrectomy is to be considered. While there can be no certainty of determination of operability prior to surgery, in those patients in whom the roentgenologic study and chemistry of the gastric secretions obviously indicate extensive carcinoma of the stomach, but in whom the evidence of secondary effects—cachexia, fixation of the mass, and palpable metastasis are not present, and in whom roentgenology demonstrates a rigid-walled stomach without peristalsis through which the opaque meal rapidly passes, exploration as to the possibility of performing total gastrectomy is distinctly justifiable.

W. R. BROOKSHER, M.D.

Mucosal Pattern Technic and Kymographic Records of the Esophagus and Stomach. Edward H. Skinner. *Jour. Am. Med. Assn.*, 109, 1963-1965, Dec. 11, 1937.

The mucosal pattern, the relief picture, or the compression technic of the mucous lining of the gastrointestinal tract, is secured by fluoroscope or roentgenogram after manipulation and gravity have adapted a thin, mucilaginous, opaque medium to the mucosal folds of the esophagus, stomach, small or large intestine. It is a study of the intimate morphologic detail of the mucosa. It amplifies the routine examination in certain details of the actual ulcer and cancer or characteristic diagnostic patterns, such as esophageal varices or chronic gastritis. Special apparatus is required (1) so that the favorable mucosal pattern can be achieved by compression, position, and posture, and (2) so that the small, aimed roentgenograms are secured at the right instant. The expense of this technical requirement seems to preclude the adoption of this technic by others than roentgenologists. There are inherent dangers to the roentgenologist in the mucosal pattern technic because of the prolonged exposure of the fluoroscopic studies which may be necessary to secure or identify the favorable filling, or pattern, which he wishes to record permanently, by the roentgenogram. Sometimes this danger is greatly increased among physicians who complete their own roentgenographic examinations, because they fail to impose on themselves the requirements of eye accommodation, because they do not have the apparatus that roentgenologists know is essential for success with this method and, more pertinently, because they lack a studied familiarity and experience with normal and abnormal mucosal patterns.

Two situations of practical and easy application of pattern technic involve (1) the lower end of the esophagus and (2) the general mucosal pattern of the stomach.

Kymography contrasts with the mucosal pattern technic in that it is entirely a record of function ex-



hibited at a chosen margin of an organ. The value of kymography in gastric diagnosis would be for the study of the muscular movements of a portion of the wall where one suspected an early cancer. Enthusiasm for gastric kymography is not warranted. The theoretical possibilities are overshadowed by an actual danger of technic and physiologic embarrassments to interpretation.

CHARLES G. SUTHERLAND, M.D.

## THE THYROID

Roentgen Therapy of Basedow's Disease. D. Negru. *Strahlentherapie*, 62, 450, 1938.

The author reviews the pathogenesis and pathologic anatomy, history of roentgen therapy, mechanism of effect of irradiation, technics advocated by a number of radiologists, and the results reported in the literature. The various objections to roentgen therapy, as, for instance, development of adhesions and injuries to skin and larynx and the occurrence of myxedema, are outlined and contradicted. The indications and contra-indications to irradiation as set forth by a selected number of investigators are quoted. In the author's own clinic, 428 cases were treated during the period 1922-1937: 77.5 per cent were women and 22.5 per cent men. The majority were between 20 and 50 years of age. During that time the technic varied considerably; now the author prefers a radiation produced at 160 kv., filtered through 0.5 mm. Cu + 4 mm. Al, with 200 r per sitting. He applies five sittings over the anterior thyroid and thymus and two lateral areas over each lobe. There are three or four days between sittings. The same area is treated again after seven days. One series takes 14 days; there are intervals of from four to six weeks between series, with a maximum of three series for the individual case. Of the 295 cases that could be followed only partially, the results were: 7 per cent cured, 22 per cent considerably improved, 55 per cent improved, and 16 per cent failures. This material, however, is not suitable for definite conclusions because most patients had received inadequate treatment. A series of 50 cases that received sufficient therapy and could be followed up for a period of from one to ten years showed that 36 per cent were cured for anywhere from one to ten years; 32 per cent were markedly improved for from one to six years; 22 per cent were improved for from one to three years, and 10 per cent, re-examined one to five years after the treatment, were failures. Only one single case of myxedema was seen following radiation therapy in the period of 15 years.

After a critical analysis of this material, the author reaches certain conclusions. He believes that one-third of an erythema dose per sitting should not be exceeded. The thymus should be included in the irradiated area. Filtration should be chosen according to the size of the goiter, although no definite difference could be seen between filtration of 4 mm. Al or 0.5 mm. Cu + 4 mm. Al. It takes at least three series, applied during a period of four months, in order to decide

whether or not x-ray therapy may be of benefit in a particular case. No injuries to the skin or larynx nor adhesions of the thyroid are seen, provided that the treatment was skillfully applied. Since roentgen therapy is a relatively harmless method it should be given a trial in all cases.

Contra-indications acceptable to the author are patients with compression symptoms, suspicion of malignant degeneration, and toxic adenoma with highly toxic symptoms from the beginning of the disease. Roentgen therapy should be discontinued as soon as the basal metabolic rate drops to +10 per cent. Roentgen therapy seems to offer 40 per cent cures in all cases, while those cured and those improved reach a total of 80 per cent. The author considers that in 10 per cent recurrences may be expected.

ERNST A. POHLE, M.D., Ph.D.

## TUBERCULOSIS, PULMONARY

The Lasting Cure of Early Pulmonary Tuberculosis. J. Burns Amberson, Jr. *Jour. Am. Med. Assn.*, 109, 1949-1952, Dec. 11, 1937.

There are seven reasons for directing attention again to the early tuberculous lesion and its cure. The nature of the early lesion is better understood now than ever before. The time of life when the lesion is most likely to appear is more clearly defined. The methods of diagnosing its presence have been developed and perfected. The subsequent behavior of the early lesion and the ways of its healing and advancement are better known. Most disabling and fatal tuberculosis originates in this lesion. Knowledge of the methods of treatment and their proper selection and application is more accurate and reliable. The far-reaching and vastly superior results of proper and timely treatment of the early lesion are firmly established.

The development of the early lesion, often called the early infiltration, may be rather abrupt, that is, within a week or a month, or it may be gradual with static periods of apparent quiescence. The patient has no symptoms or only slight to moderate constitutional ones, chiefly a loss of a few pounds of weight and a little undue fatigue. More often the physical examination reveals nothing abnormal in the chest. The roentgenogram shows, as a rule, the small area of soft infiltration in one lung. Tuberculosis takes its heaviest toll between the ages of 18 and 35. No age is immune from this danger.

The early lesion will be discovered in only a small minority of cases unless this disease is viewed as a community problem and organized searches for it are made periodically. The physician, in his capacity as a far-seeing health officer, must seek the patient. Tuberculin testing and x-ray examination of the chest, wisely planned and applied, are indispensable parts of the diagnostic method.

Rigid and prompt treatment of the early infiltration, as it appears especially in young people, with a preliminary period of from two to four months' bed rest, has

proved to be the most effective in terms of lasting recovery and avoidance of advanced relapsing disease.

CHARLES G. SUTHERLAND, M.D.

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Roentgenologic Study of Isolated Form of Pulmonary Tuberculosis. S. H. Wang, C. L. Hsu, and C. Wu. Chinese Med. Jour., 52, 817-829, December, 1937.

The authors define the form of tuberculosis first described by Assmann and termed by him "initial tuberculous infiltrate" as "the isolated form of pulmonary tuberculosis." The typical lesion is sharply circumscribed, usually round, may be in the initial, or calcified stage, and is usually unassociated with the enlargement of the tracheo-bronchial glands which is found only in childhood or initial types of the disease.

The authors found 50 cases of the isolated form in 2,000 cases of pulmonary tuberculosis of all forms. It is two or three times more frequent between the ages of 20 and 29 than any other form of tuberculosis. The sex incidence in general is similar to that in other types of tuberculosis.

Serial roentgenologic observations form the only basis for prognosis in this type of lesion. The condition must be differentiated from the metastatic neoplasms, parasitic infestations such as the cysticercus, paragonimus, and the hydatid cyst as well as from metastatic pulmonary abscesses.

W. H. GILLENLINE, M.D.

## VISCERA, TRANSPOSITION

Congenital Dextrocardia with Complete Transposition of Viscera: Report of Case. Christy Y. D. Tyau. Chinese Med. Jour., 52, 439-442, September, 1937.

Although dextrocardia with transposition of viscera has been known for a long time, it was not until 1928 that a case was reported in China.

The relative incidence of transposition discovered varies with the method of examination employed, as follows:

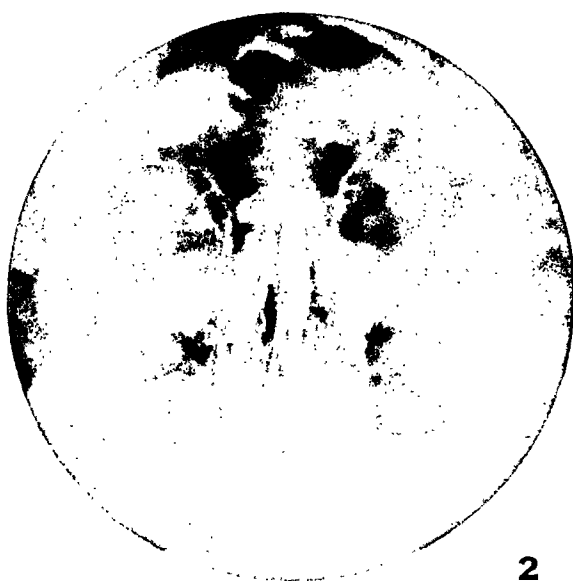
Roentgen ray	1: 1,400
Postmortem	1: 5,000
Dissecting room	1:10,000
Physical examination	1:35,000

The essayist reports a new case and in his comments states: "The greatest liability to error occurs when one examines acute abdominal cases without careful and thorough examination of the whole body, especially the heart. With such abnormal condition, the left-sided liver may be mistaken for splenic enlargement. An acute lesion of the transposed appendix may be wrongly diagnosed as diverticulitis or, in a woman, as tubal-overian disease or salpingitis. Palamountain reported a case that was diagnosed as left tubal gestation, but, upon operation, it turned out to be a gangrenous transposed appendix."

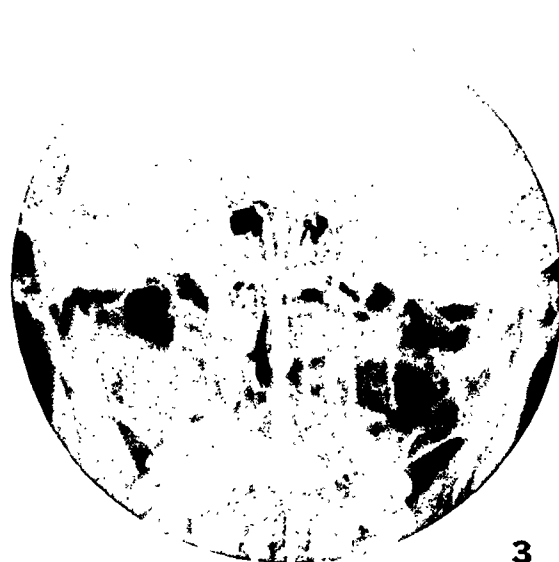
A. MAYORAL, M.D.



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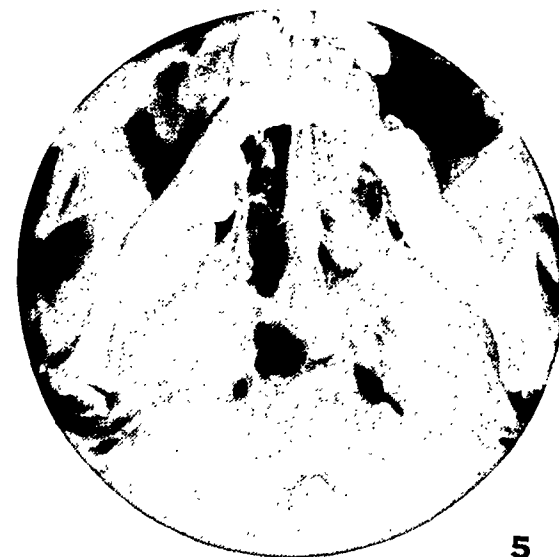
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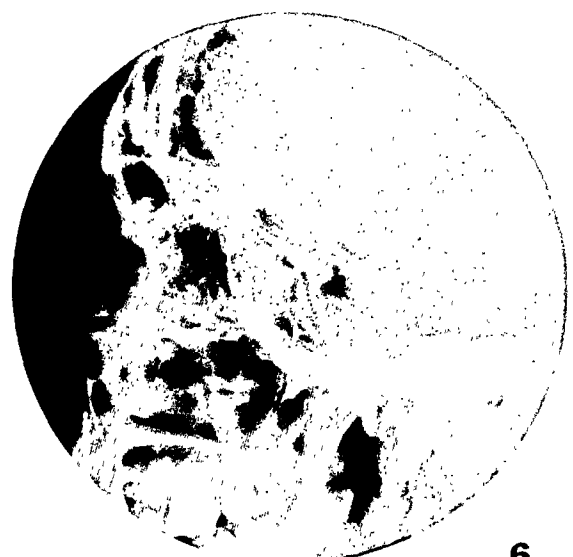
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6

***Technical Factors for Radiographs Reproduced on  
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	1	2	3	4	5	6
PROJECTION	Caldwell	Waters	Granger	Post.-lat.	Sup.-inf.	Lateral
THICKNESS	18 cm.	18 cm.	18 cm.	18 cm.	21 cm.	13 cm.
ANODE-FILM DISTANCE	30"					
P-B DIAPHRAGM	None*					
TUBE	1.5 mm. focal spot*					
FILTER	1 mm. aluminum*					
CONE	3"					
FILM	Eastman <i>Ultra-Speed</i> *					
SCREENS	Eastman <i>High-Definition</i> *					
KV.P.	68	68	68	68	75	72
MA.S.	80	120	80	90	105	20
DEVELOPMENT	Kodalk X-ray Developer (3½ min., 65° F.)*					
FIXATION	Eastman X-ray Fixer*					

\*This factor applies to all six radiographs

Eastman *Ultra-Speed* X-ray Film . . .  
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(See reverse side of this page)



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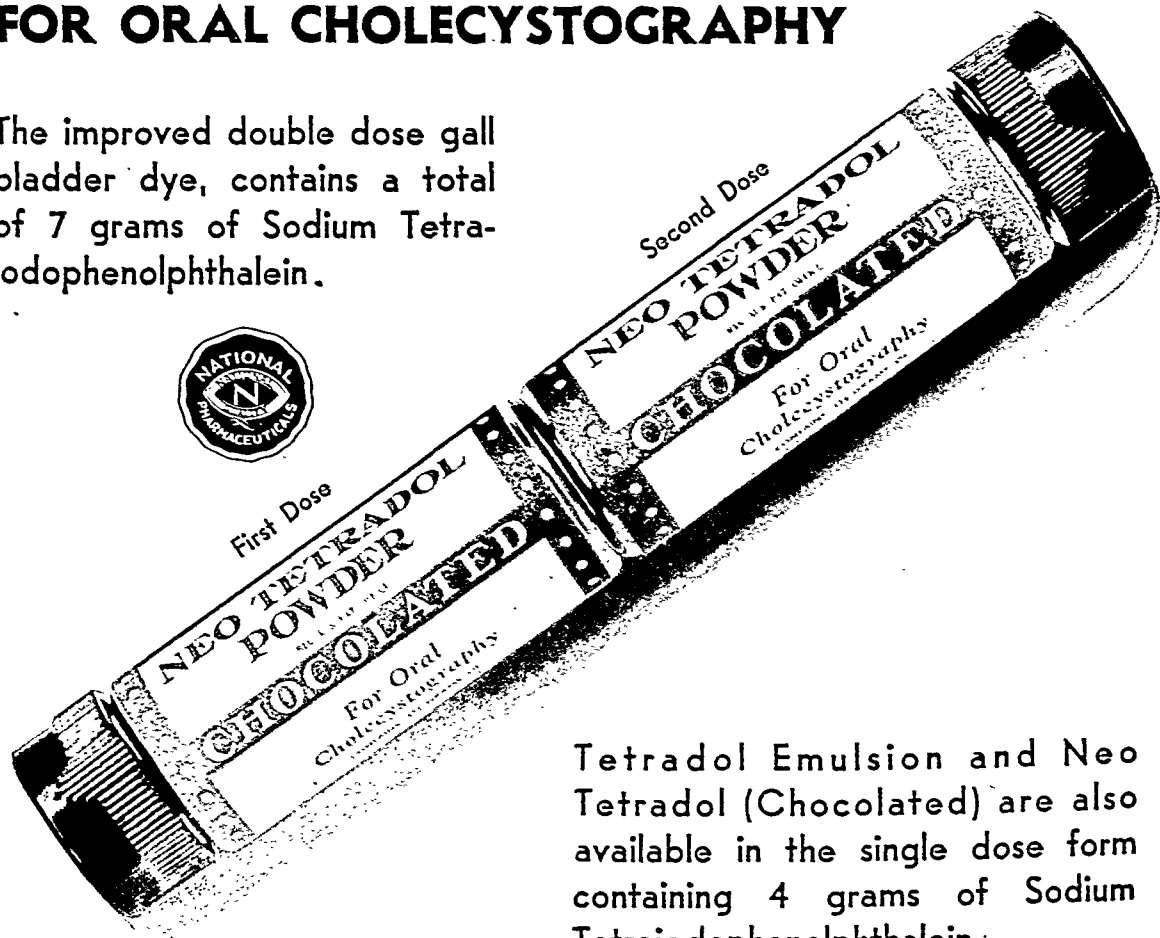
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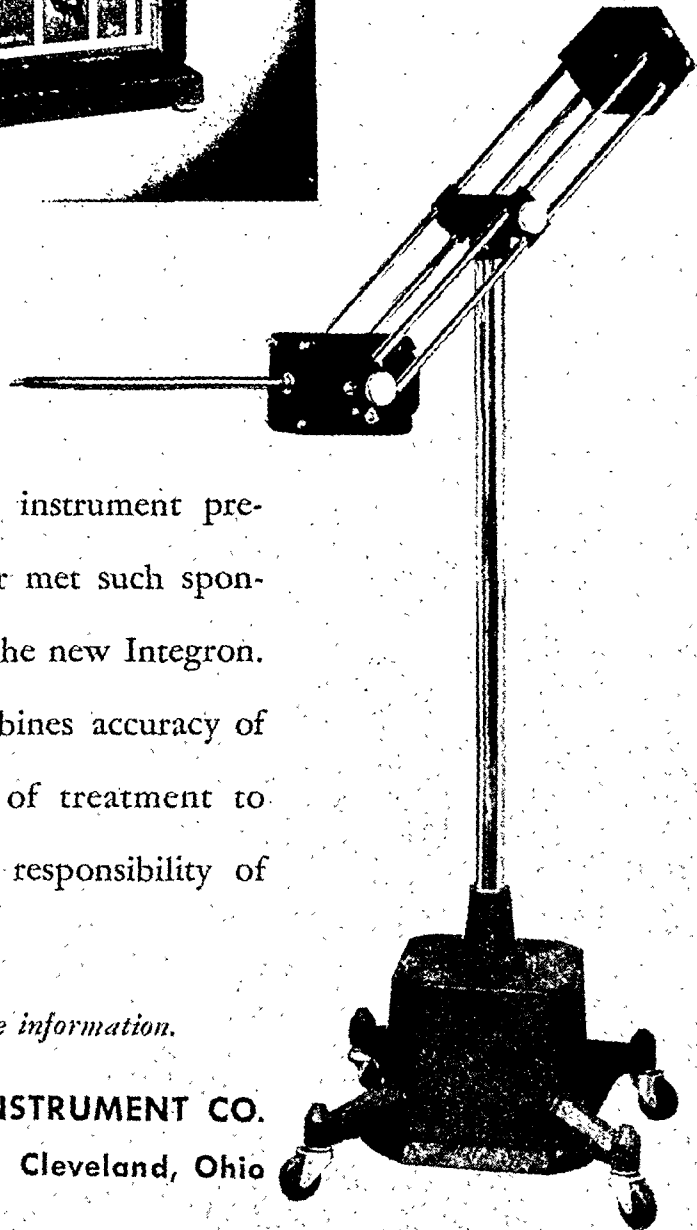
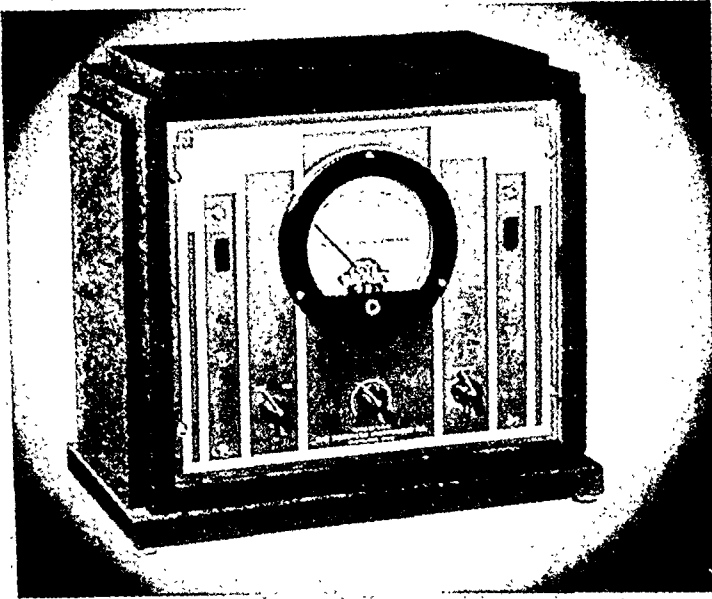
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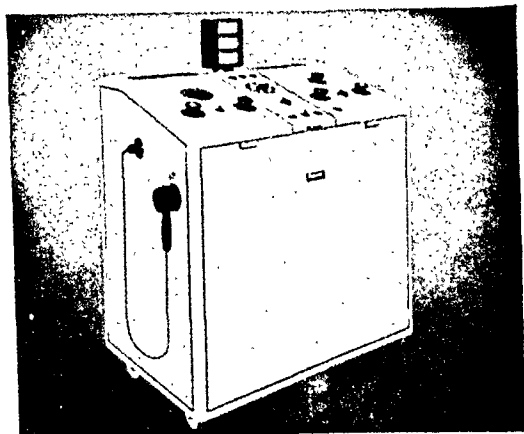
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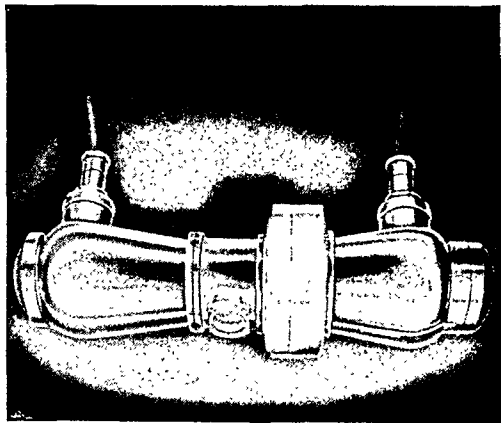
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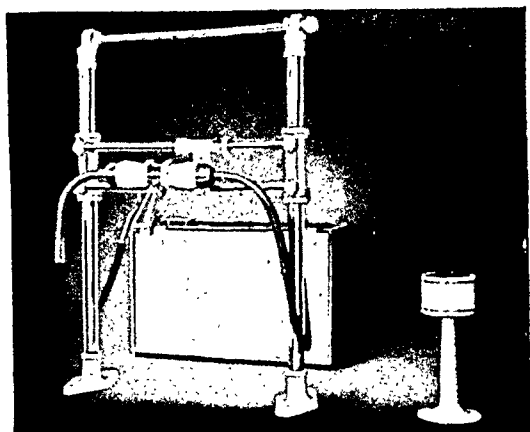
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## News Item

SEPTEMBER 24, 1938

### Amateur Picks Up Radio Plea To Own Firm for X-Ray Films

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Flood-Bound.

The important role of the ama-  
teur short wave radio operators in  
time of disaster is again being  
demonstrated throughout the  
storm ravaged states and one of  
the stories that came to light to-  
day is of unusual interest.

Last night at 9:30 P.M. radio lis-  
teners heard the following message  
being broadcasted over short wave.  
Among them was Mr. S. T. Green,  
an employee of the Picker X-Ray  
Corporation of 300 Fourth Avenue,  
manufacturers and distributors of  
X-ray equipment. He picked up a  
message addressed to his own com-  
pany.

It came in as follows:  
"Picker X-Ray Corporation —  
P-I-C-K-E-R  
Ship Westerly — W-E-S-T-E-R-  
L-Y Hospital, Westerly, R. I., all  
sizes of X-ray films via plane to  
Providence to be delivered by truck  
from Providence to Westerly . . .  
urgent need."

Mr. Green communicated with  
officials of the Picker X-Ray Cor-  
poration immediately.  
The Picker representative in  
Providence notified the New York  
office that films were delivered to  
the Westerly Hospital by 1 A.M.  
this morning.

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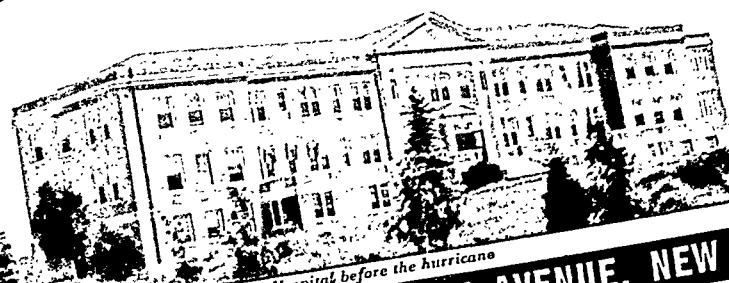


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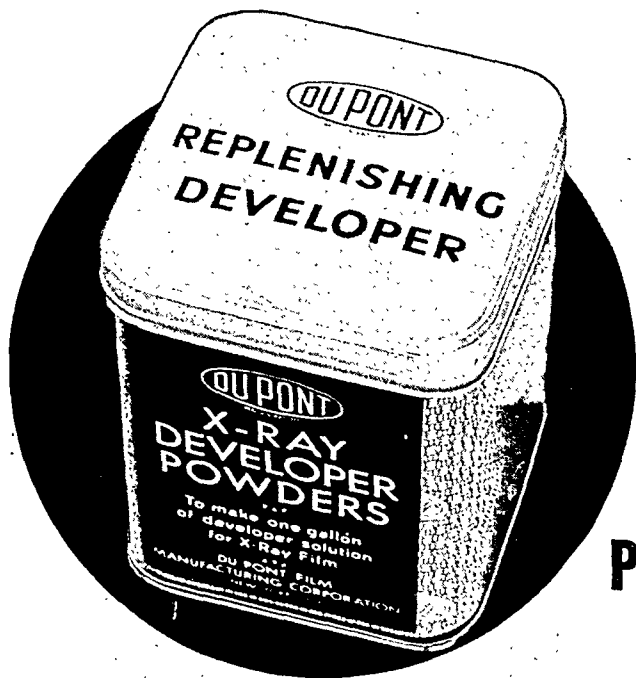
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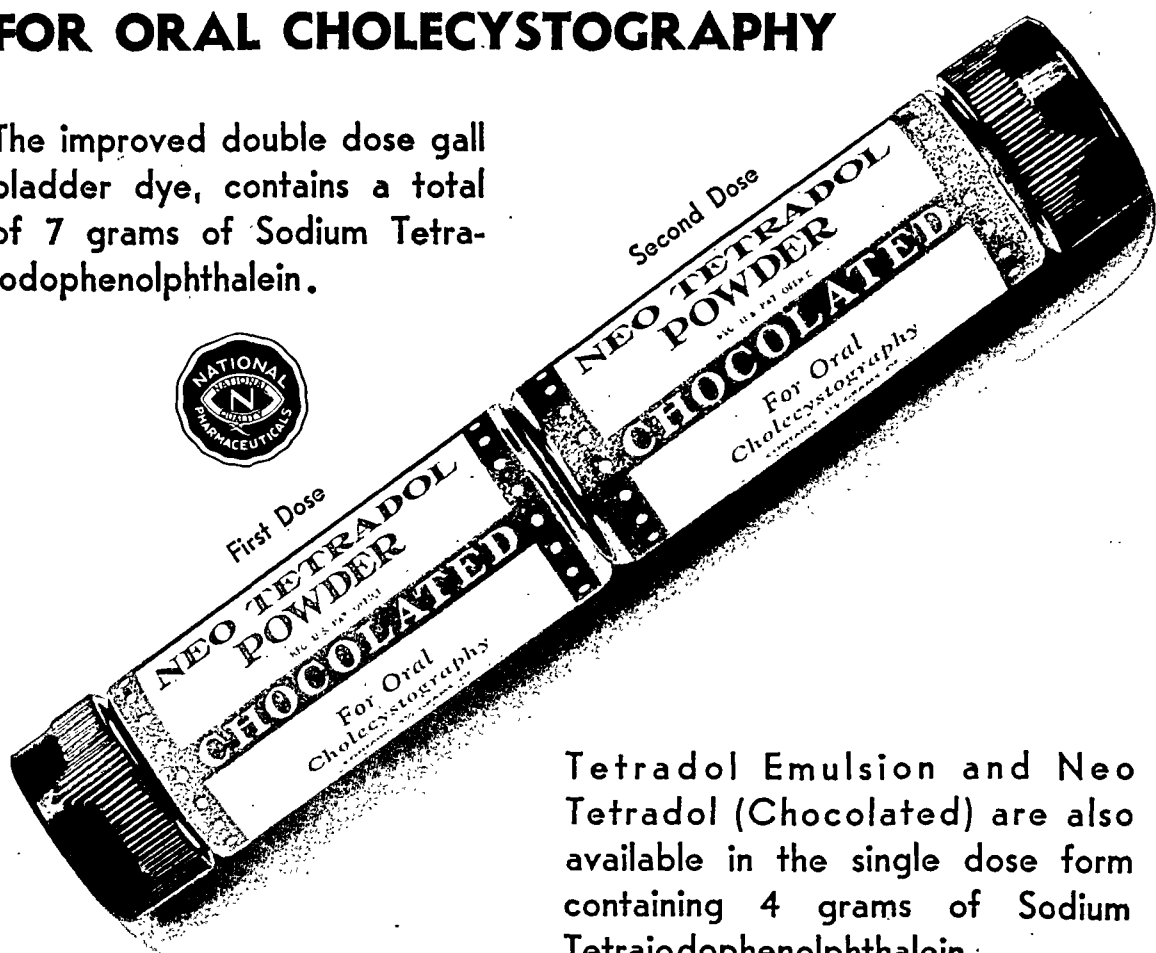
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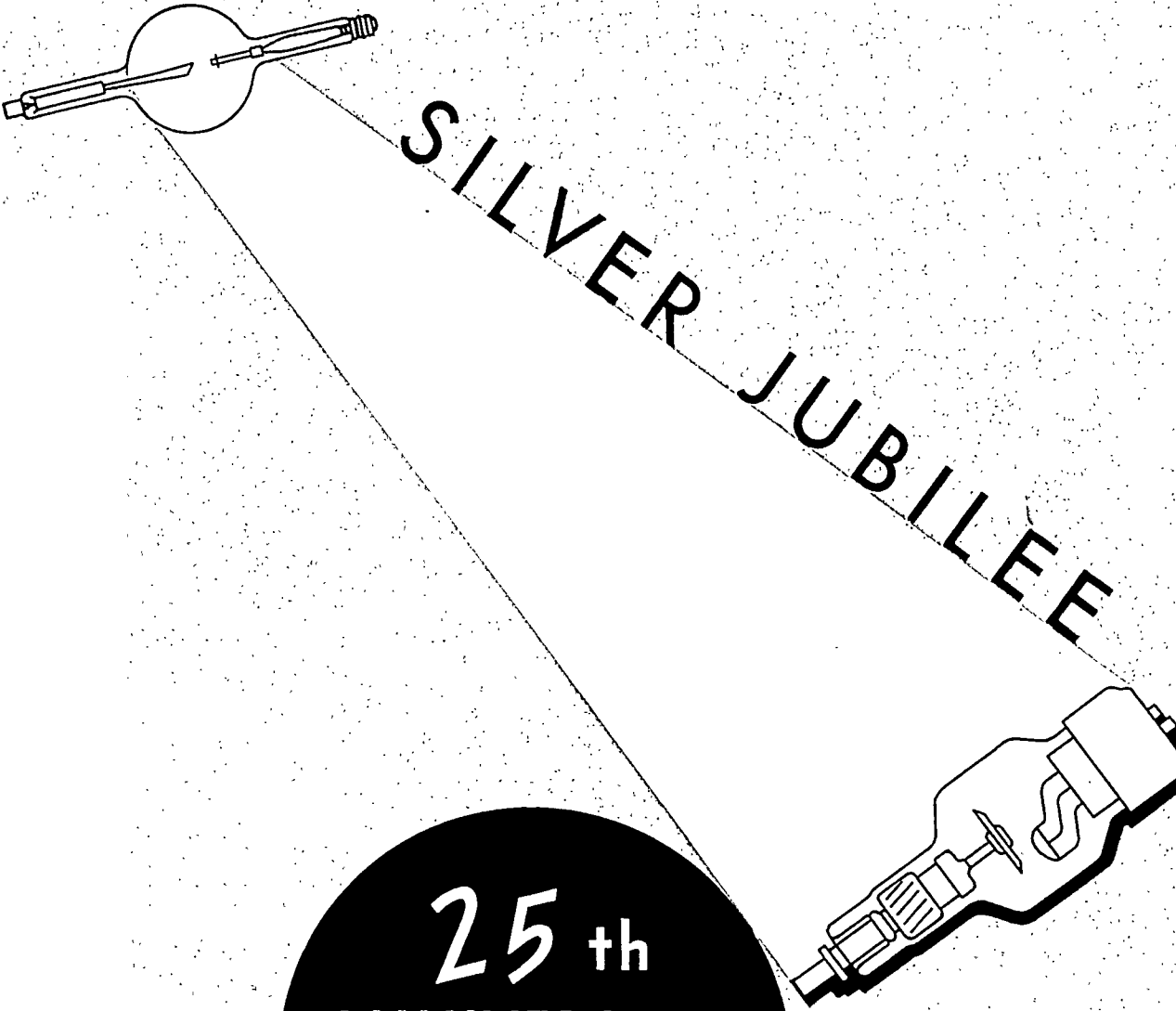
# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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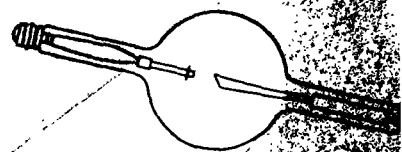
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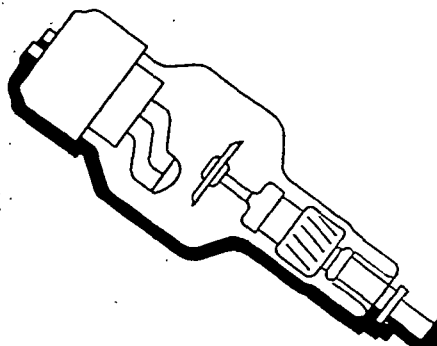
The then prevailing gas tube, even at its best, performed ~~erratically~~—was "cranky", said roentgenologists—and required considerable individual experience and judgement in its operation. Little wonder then, that Dr. Coolidge's announcement of having transformed the x-ray tube to a device of great stability, and capable of exact control, inspired eminent x-ray scientists to acknowledge it as epochal.

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# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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## DISK-LIKE ATELECTASES

By ALBERT OPPENHEIMER, M.D., Department of Roentgenology, American University of Beirut, *Beirut, Lebanon, Syria*

### I

IN various abdominal diseases one may find peculiar linear shadows in the lower parts of one or both lungs (5, 7, 9). Crossing the bases more or less horizontally, these shadows extend from the cardiac border into marginal areas, commonly at the level of the dome of the diaphragm or a little higher. They are usually almost linear, clearly defined, and

straight, but may also form a triangular ill-defined haziness diverging from the lateral portion of the linear shadow toward the wall of the chest. But for their localization, the formations resemble the shadows produced by thickened interlobar septa. They may be single or multiple, either bilaterally or at one base. In most instances, the corresponding hemidiaphragm is elevated; its respiratory excursions are diminished, absent, or paradoxical, according to the degree of paresis. A small pleural effusion may co-exist.



Fig. 1. Pleural adhesions (autoptic verification). See text.



Fig. 2. Disk-like atelectasis in left base (arrows). Bronchitis.

These changes may persist for indefinite periods, or they may subside when the clinical condition improves. It was originally held that this roentgenologic syndrome, pointing to the abdominal cavity as the seat of a disease, should direct the attention to an abdominal lesion in cases which are clinically obscure (2, 9). On the other hand, the finding is not pathognomonic of any particular morbid condition, for it is known to occur in both inflammations and tumors of almost any part of the abdomen, including such different lesions as, *e.g.*, acute pancreatitis, carcinoma of the ovary, perforated duodenal ulcer, splenic enlargement in leukemia, liver abscess, etc. (3, 10).

In the absence of conclusive autoptic findings it was assumed that these shadow lines correspond to circumscribed pleural thickening due to invasion of the pleural cavity by the underlying disease. This explanation has never been quite satisfactory. Pleuritic bands are usually more numerous, less regular in distribution, and associated with tent-like formations of the diaphragm when localized at the bases

(Fig. 1). In two cases in which I had observed the linear shadows in question, autopsy failed to reveal any morbid changes of the pleura. Klima and Pape (8) believed that atelectasis underlies the roentgen findings, but did not obtain autoptic confirmation.

Very recently Fleischner, of Vienna, showed that the linear shadows in the bases correspond, in fact, to a hitherto unknown type of atelectasis which he calls "*plattenförmig*" (*i.e.*, plate-shaped, or disk-like). Whenever respiration becomes shallow, a small bronchus may become obstructed by mucus or muco-pus, especially in the presence of increased bronchial secretion. This obviously leads to atelectatic collapse of the corresponding part of the lung; the collapsed portion retracts; the negative pressure in the pleural cavity and the comparative rigidity of the thoracic walls counteract or resist retraction, but the surrounding normal pulmonary tissue, being very elastic, yields by allowing the alveoli to dilate: consequently, the collapsed portion retracts by stretching the normal lung above and be-



Fig. 3. Anteroposterior and left oblique view. In the anteroposterior view, a linear shadow (arrows) is superimposed to an ill-defined hazy area; in the oblique view, the latter corresponds to a triangular atelectasis (white arrows), while the disk-like atelectasis is seen in front of it (black arrows). Esophagus filled with barium.

low it, but it itself remains stretched between the obstructed bronchus and the pleural surface of the lung. Hence the almost linear appearance and the more or less horizontal position of the shadow that corresponds to the atelectatic region. Fleischner describes this pathogenetic mechanism as "*gerichteter Kollaps*" (2, 3); the term indicates that in these cases collapse is oriented, or directed, by the concurrent forces of retraction, elasticity, and resistance. It is evident that this type of collapse occurs only when the atelectatic area is small and the surrounding lung tissue elastic; otherwise, the more common form of atelectasis develops, for example, as a triangular shadow radiating from the hilus downward. In accordance with well-known work of American authors (1, 6), Fleischner ascribes the production of this condition to shallow breathing as induced by pain, by inflammation in the neighborhood of the diaphragm, by exhaus-

tion causing weakness of respiratory movements, and the like.

In the majority of cases, disk-like atelectasis is transient, for it either resolves or is followed by pneumonic infiltration (drowned lung), especially *sub finem*. Hence, it is quite difficult to obtain autoptic verification. After many failures, Fleischner finally succeeded in substantiating his views by the results of two necropsies. We are able to add a third autoptic confirmation from our own experience, to be reported hereafter.

## II

Statistical data concerning the incidence of disk-like atelectases are not yet available. In reviewing 1,000 examinations made in 1936, I found six cases. Among 482 examinations made more recently there were 11 cases. The discrepancy obviously is due to the fact that of late we have

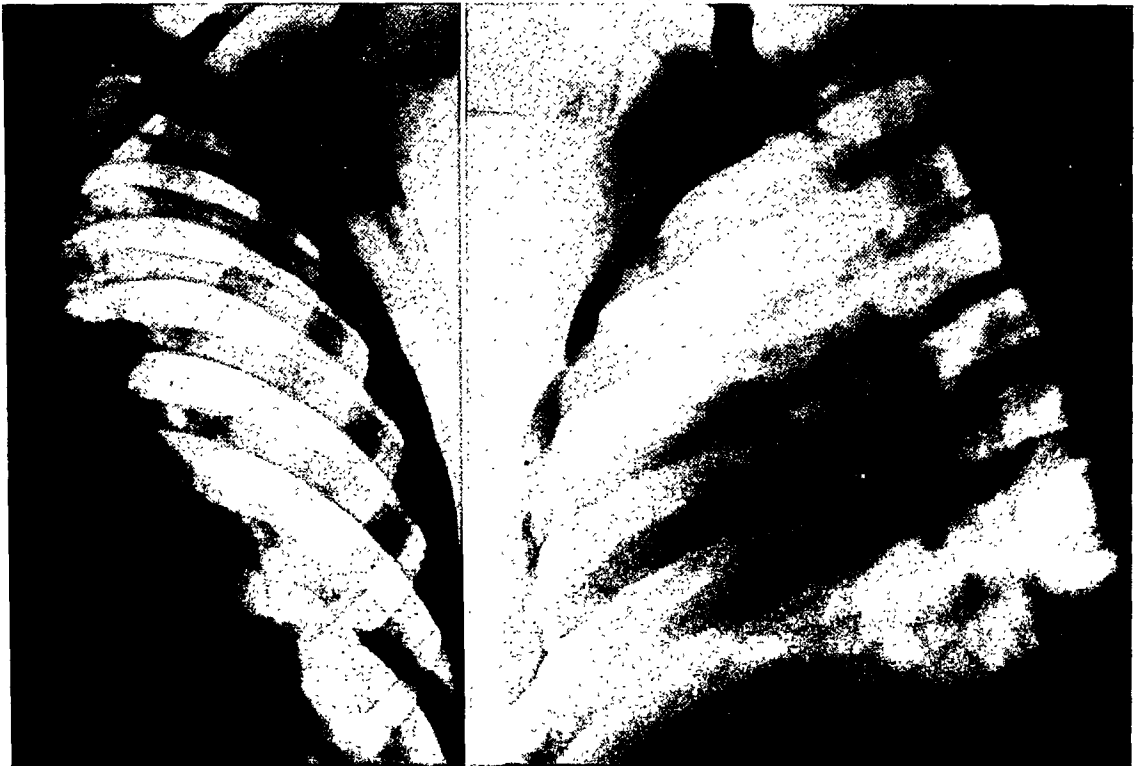


Fig. 4. Same case as Figure 3; roentgenographs taken 32 hours later (see text). Lung-fields now perfectly clear. Diaphragm lower than before.

paid more attention to this condition, and that we have examined a larger number of patients in whom we expected to find it. Precise figures are difficult to obtain anyway; for, as mentioned above, in its

leukocytosis, and no other sign of inflammation or infection. The child was unable to cough. Feeding had become difficult. Roentgen examination showed in the left lower lobe a horizontal linear, and

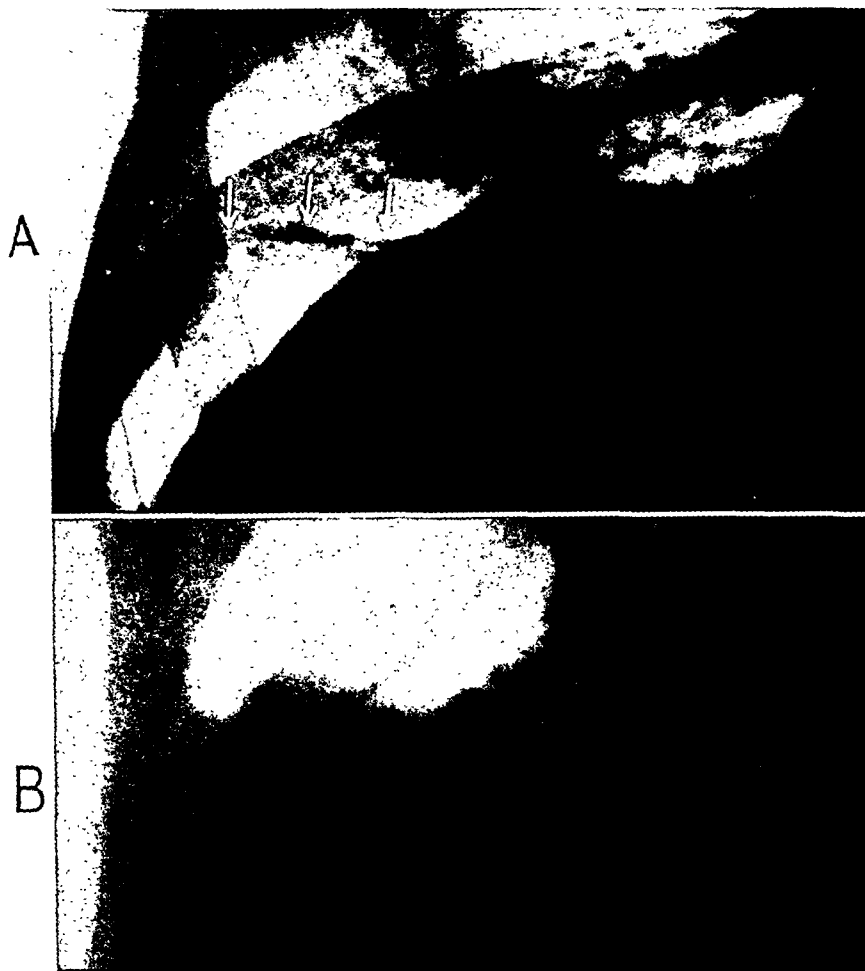


Fig. 5. Fifteen minutes after a fall, a disk-like atelectasis is seen in the right lower lobe (arrows); the fractured rib is not included in the roentgenograph (A). The right base shows pneumonic infiltration 20 hours later (B). See text.

unaltered form, disk-like atelectasis usually is transient: as soon as bronchial obstruction ceases, the lungs regain normal radiolucence. For example, in a girl two years of age, the linear shadow was found to have disappeared a couple of hours after normal respiration had become possible (Fig. 4). There had been difficulty in breathing off and on for a few weeks previous; tubular breathing was found in a small area of the left lower lobe; there was no fever, no

a triangular homogeneous shadow. The lumen of the corresponding bronchus, visible by its air filling, seemed irregularly narrowed (Fig. 3). X-ray diagnosis: two areas of atelectasis due to bronchial obstruction, probably by mucus. Suddenly, respiration became normal, the child asked for food, and, a few hours later, roentgenographs showed that both the linear and the triangular shadow had entirely disappeared (Fig. 4).

On the other hand, atelectasis of this type is often rapidly complicated by in-flow of exudate into the alveoli ("*atelektatische Anschoppung*"), as illustrated by the following example: a man 63 years of age fell on the street in front of our hospital. Within 15 minutes after the fall, roentgenographs of the lungs were taken. The right ninth rib was found fractured at its junction with the calcified cartilaginous portion. A linear horizontal shadow was seen crossing the right base (Fig. 5-A). Owing to inhibition of all respiratory movements because of pain in the injured side of the chest, the right intercostal spaces were greatly narrowed, while the right hemidiaphragm was elevated, and there was scoliotic position of the dorsal spine with the concavity to the left side. There was a well-marked prominence of bronchial markings in both bases. X-ray diagnosis: fracture of right ninth rib, chronic bronchitis, disk-like atelectasis in right lower lobe. Twenty hours later, the patient's condition became worse, and roentgenographs showed pneumonic infiltration in the region previously occupied by the linear shadow (Fig. 5-B).

In some instances, however, the atelectatic part may remain disk-shaped for long periods, as shown by the following observation. In a man 54 years of age a small carcinoma of the pyloric region had produced very large metastases in the liver. The right diaphragm was elevated and immovable. There were linear shadows in both bases (Fig. 6). Five weeks after this examination, the patient died. Autopsy was made by Dr. Ph. F. Sahyoun, and I am indebted to him and to Dr. E. Mayer for permission to publish the results of the examinations. In the left lung, about 1 cm. above the diaphragm, there is an atelectatic area 2 cm. long, extending from the anterior margin into the pulmonary tissue. The right base shows atelectasis and hypostatic pneumonia. Pleura smooth and shiny, no adhesions, no thickening, no effusion. Microscopically, the left atelectasis shows these latic fibers crowded together; some small

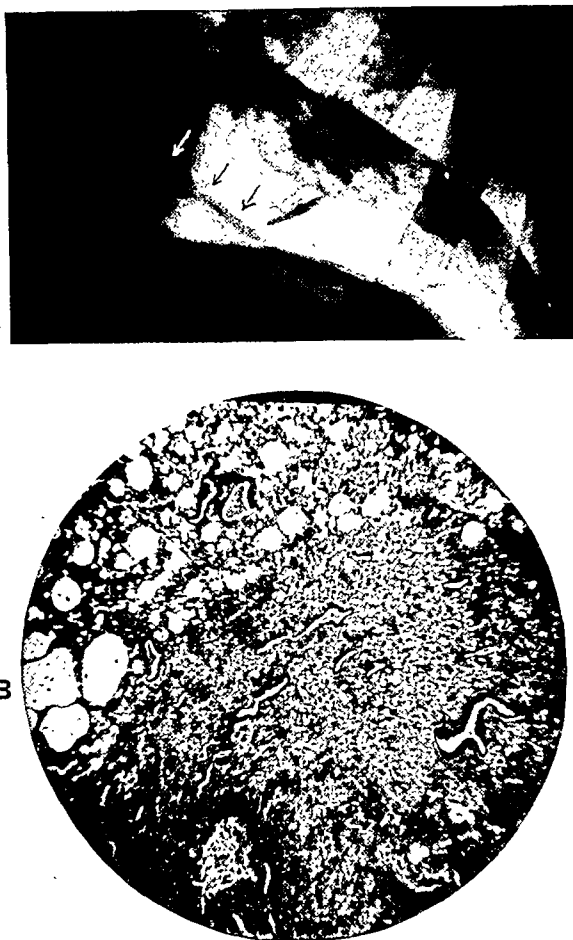


Fig. 6. Roentgenograph (6-A) and photomicrograph (6-B) of disk-like atelectasis in left base. Verhoeff elastica stain, low power magnification. The left upper part shows normal, the right lower part atelectatic lung tissue. See text.



Fig. 7. Deviation of interlobar septum (white arrows), with a sharp angle (x) due to traction by a disk-like atelectasis (black arrows). Retouched.



Fig. 8. Deviation of esophagus during forced inspiration (*left*). No deviation during expiration (*right*; retouched). A disk-like atelectasis (arrows). See text.

bronchi contain mucus, others epithelium (post-mortal). The alveoli in the normal adjacent parts are rounded. There are a few thrombosed capillaries in the neighborhood of the atelectatic area. In size, shape, and localization, this atelectatic area corresponded to the linear shadow seen roentgenologically; and it is noteworthy that the pleura was found normal. The atelectasis in the right base obviously was complicated by pneumonic infiltration during the interval between roentgenologic and autoptic examination. Unlike Fleisch-

ner, we did not find in our case the elastic fibers in the atelectatic area arranged horizontally, nor the alveoli in the surrounding tissues elongated. Nevertheless, the findings confirm Fleischner's observations and prove that the linear shadows in question actually correspond to atelectases of a peculiar type, but are not due to pleural thickening.

The cases above described are merely illustrations to show the various factors involved in the production of disk-like atelectases. Shallow breathing is obviously an essential cause, irrespective of the condition underlying it. Besides the above instances, disk-like atelectases were found by us in one patient with acute cholecystitis; in two elderly people with bronchitis; in the presence of a small foreign body in the lower bronchus; in two cases of resolving pneumonia; in one patient with obscure bronchial stenosis; and in several instances in which complete clinical data are not available. The youngest of our patients was 2 years old, the eldest 76; nine were males, seven females. The type of chest, flat, short, or broad, does not play any part in this respect.

### III

In the differential diagnosis, deviation of neighboring organs toward the atelectatic region is an important finding. Al-



Fig. 9. Disk-like atelectasis in left lower lobe after resolution of lobar pneumonia.



though, of course, not pathognomonic of atelectasis, this deviation of, *e.g.*, the mediastinum, is significant in correlation with other roentgen signs of pulmonary collapse. In a discerning study of these secondary or accompanying changes, Fleischner showed that interlobar septa may become displaced toward the collapsed region at its level (4); he also found in the presence of disk-like atelectasis a normal stomach shifted upward in the supine position when the right diaphragm was relaxed (2). In one case (Fig. 7), deviation of the septum was also found by us; in another, I saw the esophagus shift toward the collapsed area (Fig. 8); the fact that this displacement occurred only during forced inspiration, but was absent during expiration, supports the view that collapse occurs in discoidal form when the power of retraction is outweighed by the resistance of the walls of the chest, wherefore during inspiratory expansion of the chest the collapsed area retracts organs that are movable. Of course, no displacement occurs when the mediastinal organs are bulky, rigid, or fixed by some morbid process, as in cardiac enlargement, pericardial effusion, aortic sclerosis, etc. Generally speaking, and in any type of atelectasis, displacement of the mediastinum is more marked in children than in adults, because obviously the juvenile organs are less strongly fixed by connective tissue, the latter being more elastic in young persons.

Theoretically, one may anticipate that in some cases it will be difficult to differentiate between a disk-like atelectasis and a thickened interlobar septum; but in practice we have not yet met with this question, the localization having been quite different from that of the interlobar fissures, even from those of supernumerary lobes. The complete disappearance of the shadows within a few hours could not possibly be accounted for by any form of

interlobar pleurisy. Besides the latter, there is no other morbid condition we know of that produces similar roentgen findings.

# SUMMARY

The roentgenologic appearance of a peculiar type of atelectatic collapse is discussed. Linear shadows in the bases are shown to be due to disk-like atelectases, as already described by Fleischner. Clinical and autoptic findings suggest a correlation with impaired respiration. The collapsed area may re-expand within a few hours, and the shadows disappear; but the collapse may also be complicated by pneumonic infiltration. There is no direct correlation with any type of abdominal disease; indirectly, such a disease may be responsible for atelectasis when it leads to shallow breathing. The shadows in question are not due to pleural thickening, as evinced by the results of autopsy.

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# THE ROENTGEN DIAGNOSIS OF INTUSSUSCEPTION

By JOSEPH B. KIRSNER, M.D., and JOHN FRANCIS MILLER, M.D., *Chicago*

From the Department of Medicine and Division of Roentgenology, University of Chicago

ROENTGEN examination has been used rather extensively in the diagnosis of intussusception since Ladd (1), in 1913, and Lehmann (2) and Groedel (3), in 1914, first demonstrated its diagnostic value. The purpose of this report is to evaluate the roentgen criteria of intestinal invagination and to present the roentgenographic observations in a series of seven patients.

Intussusception usually occurs in infancy. Although many theories have been postulated (4), the exciting causes (in infants) are not definitely known. In older children and adults, the predisposing conditions include ulceration of the bowel, Meckel's diverticulum, and abnormal growths such as polyps, myomas, lipomas, or cysts (5). Malignant tumors which grow in the direction of the bowel lumen and do not cause fixation of the intestine to surrounding structures may also cause invagination.

The symptoms (6) are periodic attacks of colicky abdominal pain, vomiting, and diarrhea with the passage of blood and mucus per rectum. On physical examination, an abdominal tumor may be palpable. This mass can change in contour and location, and may even disappear. Since the x-ray signs are correlated with the underlying structural changes, a preliminary consideration of the pathology is essential to this discussion.

Most invaginations are of the so-called descending variety. One portion of the bowel wall invaginates into the lumen of an adjacent part of the gut. The intussusception is thus comprised of intussusceptum, consisting of an entering tube and returning layer, and intussusciens, the sheath or receiving tube.

The four common types (7) are:

1. Ileocecal—the most frequent, in which the ileum and ileocecal valve pass into the cecum.
2. Colic—in which the large intestine is prolapsed into itself.
3. Enteric (ileal)—in which the small bowel alone is involved.
4. Ileocolic—in which the ileum prolapses through the ileocecal valve.

The growth of an intussusception occurs exclusively at the neck of the intussusciens. The driving force is supplied entirely by the ensheathing layer. Its circular fibers contract strongly above, driving the intussusception on and forming a fixed point from which the longitudinal fibers can act (8). There may be considerable space between the sheath and the invaginated portion, especially in the ileocolic type, allowing great mobility of the intussusception, and accounting for the spontaneous reduction which frequently occurs (9, 10). The obstruction is produced by the contraction of the sheath, as well as by the intussusceptum (7). An actual block does not exist and the continuity of the intestinal lumen between oral and distal segments remains intact. However, the twisting and compression of the mesentery impairs the blood supply of the invaginated portion. The intussusceptum becomes congested and edematous so that it fills the intussusciens completely. Ulceration, gangrene, and perforation may follow. Adhesions (11), as well as edema, prevent reduction, and usually develop between the two layers of the intussusceptum, due to a local inflammation. The further consequences are stenosis and complete obstruction. The proximal bowel becomes distended, the haustra are stretched, and potential spaces appear between the separated plicæ. The dis-

tinguishing feature in chronic intussusception is incomplete obstruction of the bowel lumen. There is usually little, if any, interference with the blood supply. The intussusceptum is constantly changing, no edematous segment of gut is produced, and occlusion of the bowel is more or less intermittent. In acute invaginations the ensheathing cylinder shows little change, aside from congestion. In the chronic type it may be considerably thickened (7).

The diagnostic value of roentgen examination in intussusception has been questioned by Panner (12), who emphasizes the variability in findings and claims that stenosis is the only possible diagnosis to be derived from this procedure. Porcher (13) likewise believes that there are no pathognomonic findings, and he presents in evidence three cases diagnosed as intussusception by x-ray in which operation disclosed tuberculosis of the bowel, neoplasm with volvulus, and congenital non-rotation of the bowel with stenosis. There have been several reports of negative roentgen examinations in subsequently proved cases of intussusception (14, 15). It is possible that the examination was done at a time when the invagination was spontaneously reduced. Aside from these isolated accounts, the evidence accumulated in numerous case reports (16, 17, 18) indicates that roentgen examination is a helpful diagnostic method in bowel invaginations. While Da Costa (19) urged its use in all suspected cases of intussusception, it is generally agreed that the x-ray is most valuable in the diagnosis of atypical subacute and chronic types of obstruction (20).

The relative merits of the opaque meal and the barium enema have been considered only occasionally. Renander (21) and Edberg (22) favor the oral type of examination. In the case studies of Groedel (3) and Altschul (23), this method gave positive findings, whereas colon fluoroscopy was negative. Castronovo (24) and Panner (12) advocate the use of both procedures. It is possible, according to the latter, to obtain roentgen findings with an opaque meal just as characteristic and

illustrative of all details as with the opaque enema. However, the barium meal has given negative results in cases of intussusception diagnosed by the barium enema (2, 12). The few descriptions of roentgen findings with the opaque meal have emphasized obstruction, filling defect, and alterations in the caliber of the bowel, and in the position of the cecum and ileocecal valve. Other observations include distention of the haustra proximal to the obstruction (21) and delayed emptying time of the ileum (25) due to a relative stenosis produced by the invagination. Ashbury (26) and Weaver (27) have also reported the ileum apparently entering the cecum posteriorly. The significance of this finding is questionable since it has been observed in normal cases (28). The barium meal is of greatest value in the diagnosis of small bowel invaginations. In all other types, colon fluoroscopy is to be preferred. It not only shows the anatomy of the colon to better advantage, but is desirable because it is less likely to interfere with subsequent surgery. The use of post-evacuation films is recommended since they frequently give excellent views of the mucosal pattern. Jacobi and Lust (29) recently have demonstrated the advantages of mucosal relief study of the colon.

As the enema is administered, a hindrance to the flow of barium usually occurs. This obstruction is produced by the apex of the intussusceptum and the contraction of the ensheathing layer. If the invagination is loose, the obstruction will often recede for a varying distance by increasing the pressure of the enema. Under such circumstances there is an irregular filling of the colon proximally (21). Complete reduction may result, allowing the colon to fill out normally. This fact has encouraged the use of the barium enema for therapeutic as well as diagnostic purposes in selected cases (30, 31). This movable type of obstruction has been reported by many authors. It is more likely to occur in chronic recurrent invaginations in which the blood supply of the intussusceptum is not appreciably impaired. In

the one case in which it was not observed, our x-ray diagnosis of intussusception proved erroneous. In another patient, the obstruction was partially movable despite the presence of fibrous adhesions. Movable obstruction is not completely diagnostic of intussusception since pedunculated tumors can give similar findings (21, 32). If barium is able to pass between the sheath and the invaginated portion, a characteristic forking of the contrast substance occurs at the point of obstruction. The barium diverges into two narrow channels enclosing the intussusceptum as a thin cylindric shell within the intussusciptum (34, 35, 36). The length of the forking depends on the length of the invagination and on the anatomic space between the cylinders. It is possible, of course, that any rounded mass projecting into the lumen of the bowel, but not completely obstructing it, will present a similar appearance. Baastrop (37), for example, has observed a forked opaque meal shadow due to an enormous coprolith, measuring  $8 \times 12$  cm. The barium will then enclose a central filling defect, either rounded or cone-shaped, corresponding to the intussusceptum. This defect is not commonly found in other lesions causing obstruction (36). If the intussusception is fixed, the barium enema will be completely obstructed, although this obstruction, in itself, is not characteristic. A cupola effect, or cupping in the column of barium, is produced as the contrast substance meets the intussusceptum (22, 31, 35). The barium then assumes a U-shaped configuration. While this deformity has been frequently described (30, 31) we have noted it in only one case. Kerley and LeWald (18) consider it characteristic of intestinal invagination. The haustra of the bowel about the mass are often distended (21). Barium fills the spaces between the stretched plicae, and a typical appearance, likened by Muff to an accordion, can be visualized. Case 5 demonstrates this feature. A tumor corresponding to the filling defect is often palpable at the site of obstruction (26, 32, 33). Under manipula-

tion this mass is likely to alter in size or shape depending on the degree of reduction of the invagination, in contrast to the usually more fixed nature of a carcinoma of the colon. It should be emphasized, in this connection, that what may appear to be a partial reduction actually can represent complete disinvagination with the persistent filling defect now representing tumor. This occurred in Case 7.

If barium enters the lumen of the intussusceptum, its shadow appears in the center of the defect as a streak parallel to the long axis of the intestine (38). Although Davis and Parker (36) have also made this observation in one of their cases, it is an infrequent finding. The normal mucosal appearance of the large bowel shows a certain symmetry in the pattern of the folds (39). Transverse folds predominate in the cecum, ascending, and transverse colon; longitudinal folds are present in the descending colon and sigmoid. Alterations in the mucosal pattern of the colon occur in intussusception as well as in other conditions. In fact, Sussman (33) reported compression of adjacent mucosal folds in one of his cases; stretched mucosal folds have also been described (40).

The mucosa of the ileum appeared unusually swollen in a case of carcinoma of the cecum with ileocolic invagination (41). This abnormal pattern may represent edema as a result of irritation by the intussusception. A similar appearance has been noted in one of our cases (Case 7), also a carcinoma of the cecum with an ileocolic invagination. Since Templeton has noted this finding in carcinoma without intussusception, it is possible that the localized mucosal swelling chiefly represents tumor infiltration. Indeed, the "relief" picture in malignancy often shows rounded or irregular filling defects with collections of contrast medium in the crater-like depressions on the surface of the tumor (39). Proper evaluation of this mucosal abnormality is not possible at present and must await further studies of the mucosal pattern of the colon in pathologic conditions.

## CASE 1

N. B., a three-month-old male infant was brought to the hospital because of regurgitation of his feedings and the passage of a stool containing mucus and blood. On examination, slight tenderness was elicited over the right upper quadrant of the abdomen. The patient was observed to cry out at 15- to 20-minute intervals as if in pain, the abdominal tenderness increased, and rigidity was noted over the ascending colon. Several more bloody stools were passed. The next day, moderate abdominal distention was present and a questionable mass appeared in the right upper quadrant. On rectal examination, no masses were felt but a large amount of mucus and blood-tinged fluid was passed. Intussusception was considered and the patient was referred for roentgen studies. At colon fluoroscopy the barium was seen to hesitate for some time at the splenic flexure, the colon then filling slowly. Under manipulation, the barium passed across to what was thought to be the hepatic flexure (one observer considered it cecum). The remainder of the colon and the small bowel could not be filled. The roentgen impression was intussusception, but surgical interference was deferred. The patient continued to be distended, and a questionable, rounded mass was again felt two inches below the liver. The same evening, however, there was a distinct improvement; the patient expelled flatus, he retained water given by mouth, and his cry became more lusty. Several loose stools were passed containing small amounts of blood and mucus. He was discharged at this time, against advice. Four months later, in response to a follow-up letter, it was learned that the patient had been in excellent health.

*Impression.*—Probable ileocolic intussusception—spontaneously reduced.

*Comment.*—The roentgen findings in this case are merely those of a temporary and movable obstruction. Despite the absence of such typical signs as filling defect or U-shaped deformity, in view of the defi-

nite clinical picture intussusception was most likely. It is possible, also, that the enema aided in the spontaneous reduction of the intussusception.

## CASE 2

G. B., a four-year-old girl complained of abdominal cramps, nausea, vomiting, and diarrhea for two days. On the day of admission she experienced intermittent cramping pain with watery bowel movements almost every hour. The abdomen was soft. There was an oval tumor palpable just below the umbilicus and extending almost to the symphysis. This mass was rather hard, smooth, and movable, and could be felt on rectal examination. More bloody stools were passed, but on examination several hours later, the mass could not be located. With a barium enema the entire colon filled easily and completely. A mass which was palpable at the beginning of the examination had disappeared at its close. The appendix was seen and the terminal ileum filled. Conservative management was continued and for three days the patient improved. At this time the abdominal mass noted originally was again palpable. The patient also passed a formed stool streaked with blood. A tentative diagnosis of recurrent intussusception was made and the patient was transferred to surgery. At operation a large amount of clear yellow fluid escaped from the peritoneal cavity. An intussusception was found involving 20 cm. of ileum. This portion of the bowel appeared obviously damaged and a small perforation was seen in the intussusception. The entire involved bowel was resected and the ends of the small intestine were brought to the surface as a gun barrel fistula. The patient made a gradual recovery after the two loops of bowel were united. She has had no further difficulty with her gastro-intestinal tract. The surgical specimen consisted of 36 cm. of ileum; the pathologic diagnosis was gangrene of small intestine.

*Impression.*—Recurrent ileo-ileal in-

tussusception with gangrene of involved small intestine.

*Comment.*—The disappearance of the palpable abdominal mass at the completion of the x-ray examination indicated

mass lying transversely above the umbilicus was palpable. Intussusception was suspected and the patient was referred for roentgen studies. With a barium enema, difficulty was experienced in filling a re-

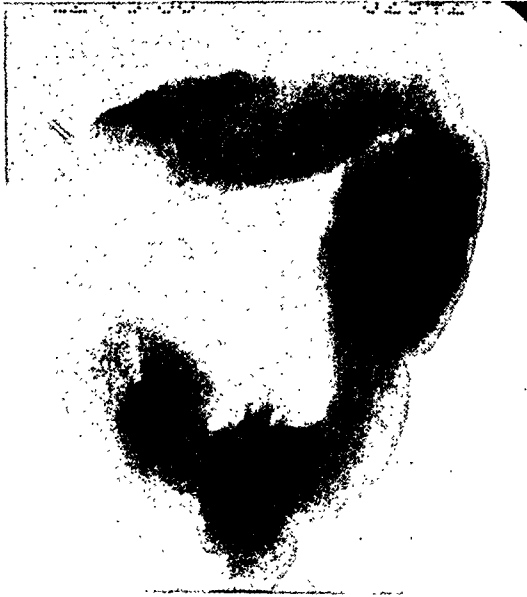


Fig. 1.

Fig. 1. Case 3. Colon completely filled to the hepatic flexure where a convex intraluminal obstruction is shown. Barium is present between the intussusceptum and intussusciens.



Fig. 2.

Fig. 2. Case 3. Illustrates partial reduction of the invagination as a result of the enema. The tumor of the ileum projecting into the cecum is well outlined by thin lines of barium.

that the pressure of the enema was sufficient to reduce the intussusception. Many similar cases have been described in the literature. The recurrence, of course, necessitated surgical interference.

### CASE 3

W. M., an eight-month-old male infant, for two weeks before admission had experienced abdominal pain, evidenced by a drawing up of his legs and crying. There was occasional vomiting, but the stools were normal. The symptoms then disappeared, except for a mild attack of pain and vomiting one week prior to admission. Two days before entry the vomiting recurred and enemas yielded a small amount of fecal material, not containing blood. On examination the patient was well developed and nourished, crying intermittently as if in pain. A sausage-shaped

dundant descending loop of colon. There appeared to be an obstruction which receded in the face of the advancing barium column, probably invaginated bowel which was being pushed out of the transverse colon. A film taken at this stage showed complete filling of the colon to the junction of the proximal and middle thirds of the transverse colon. The injection of barium was continued, whereupon the patient had an explosive defecation, after which barium passed on farther into the colon. Evidently this was due to a release of the intussusception, allowing gas and other contents of the small bowel to be evacuated. A second film showed a vague mass faintly outlined by barium in the cecum. At fluoroscopy the next day the colon was easily filled to the region of the cecum at which point a large mass, believed to be the intussusception, was visu-

alized. Examination indicated that barium given previously had left the intestinal tract. This time the colon filled promptly and completely, as far as the hepatic flexure, where there was a complete obstruction to the barium. An egg-shaped mass, measuring  $40 \times 25$  mm., was outlined.

At operation a tumor mass was palpated in the ileocecal region and found to be an ileocolic intussusception. This was partially reduced, further progress being prevented by firm fibrous adhesions. A tense, round mass, measuring 3.5 cm. in diameter, was palpated at the ileocecal junction. It could be pressed forward into the cecum, or backward into the ileum, in which latter case it seemed to produce a complete obstruction. The tumor, 15 cm. of ileum, the cecum, and a portion of the ascending colon were excised, and a lateral anastomosis was made between the proximal ileum and the transverse colon. The patient experienced a rather stormy post-operative course but gradually improved, and was discharged from the hospital the twelfth post-operative day. The pathologic diagnosis was enterocystoma of the ileum with ileocolic intussusception.

One month later the patient re-entered the hospital because of vomiting of two days' duration. He was moderately ill and somewhat dehydrated. The abdominal incision was well-healed. An indefinite mass was felt in the right upper quadrant. Rectal examination was negative. With barium enema, the colon filled up to the point of anastomosis of the colon with the ileum. A diagnosis of recurrent intussusception was made and the patient was again operated upon. An intussusception of the ascending into the transverse colon was found, producing an obstruction between the ileum and the transverse colon. This was reduced and the end of the ascending colon was sutured to the anterior abdominal wall to prevent further recurrence. The subsequent course was uneventful. The stools became normal and the patient was discharged two weeks after admission. He has since been in excellent health.

*Impression.*—Ileocolic intussusception due to enterocystoma of the ileum with recurrent, post-operative intussusception of the ascending into the transverse colon.

*Comment.*—This case demonstrates several of the accepted roentgen criteria for the diagnosis of intussusception: (1) Obstruction to the column of barium; (2) A palpable mass at the site of the obstruction; (3) An intraluminal filling defect outlined by thin streams of barium passing between the intussusceptum and the intussusciens. Here, also, the enema effected a partial reduction of the invagination.

It is interesting to note that in spite of the firm, fibrous adhesions found at operation, the obstruction possessed a certain degree of mobility. Enterocystoma of the ileum as a cause of intussusception is infrequent in the literature. An enterocystoma of the ileum without intussusception was discovered in another case not included in this series.

#### CASE 4

J. R., a 51-year-old male entered the clinic with a history of intermittent, mid-abdominal pain, rumbling, gurgling, vomiting, and constipation, all of one month's duration. There had been a weight loss of from 15 to 20 pounds. Physical examination revealed evidence of a mild secondary anemia. The patient was admitted to the hospital for more complete studies. With oral barium the esophagus, stomach, and duodenal bulb were normal. There was an unexplained broadness of caliber of the terminal ileum. At colon fluoroscopy, the sigmoid and descending colon lay on the right side; the splenic flexure was in its usual position. The cecum lay well up beneath the liver. Films of the completely filled and partially filled colon did not show any organic lesion. Another film, however, after defecation, demonstrated a large globular mass of barium in the right upper quadrant. Below this mass of barium was a faint shadow which had colonic haustra. The

incomplete filling of the ascending colon and cecum was attributed to an intussusception in the region of the hepatic flexure. Several films taken for mucosal study showed barium scattered throughout the



Fig. 3. Case 4. Film of the filled colon demonstrating no lesion.

descending and transverse colon. A polypoid mass in the region of the hepatic flexure was noted. At the second colon fluoroscopy, the colon filled rapidly. A redundant loop of sigmoid and colon lay on the right side. The splenic flexure was in normal position. The enema stopped abruptly in the region of the hepatic flexure. On compression, a faint polypoid mass could be made out through the barium shadow. When the patient was turned, the colon appeared to expand around this mass. Barium could not be forced beyond this point of obstruction. After evacuation of the enema a film again demonstrated the mass, which appeared invaginated into the normal colon. There was an abrupt demarcation between this mass and normal, collapsed colon. The x-ray impression was intussusception sec-

ondary to carcinoma of the hepatic flexure. The intussusception apparently had occurred after the initial examination one week earlier.

At operation no intussusception was discovered. An intraluminal carcinoma of the hepatic flexure, 10 cm. in diameter, was found attached by fibrous adhesions to the gall bladder. There were no gross visceral metastases. The mass was resected and an ileo-transverse colostomy performed. Recovery was uneventful. The patient was seen in the clinic three months later. He had been quite well and had had regular bowel movements. There were no palpable abdominal masses.

*Diagnosis.*—Carcinoma of hepatic flexure of colon with partial bowel obstruction.

*Comment.*—This case illustrates that the accepted criteria for the roentgen diagnosis of intussusception do not always hold. In favor of the diagnosis was the presence of an obstruction with an intraluminal filling defect and palpable mass; also the incomplete filling of the ascending colon and cecum. On the film, the mass did appear to be invaginated into the hepatic flexure. Against the diagnosis, possibly, was the fixation of the mass and the abrupt transition from normal to pathologic bowel. It is possible, of course, that an intussusception did exist at the time of fluoroscopy, and had reduced itself. But this would seem unlikely in view of the presence of fibrous adhesions surrounding the mass. The lesion was not shown on a film of the filled colon.

#### CASE 5

L. C., a boy six years of age, had been well until approximately three months previously. At this time he complained of low abdominal pain of an intermittent, recurrent nature. There were frequent vomiting spells every one to two days. His appetite had failed gradually and he had lost 20 pounds at the time of admission. The stools were hard, but otherwise negative. On examination the patient was



rather emaciated. The heart and lungs were normal. The abdomen was very tense and board-like. Rectal examination was negative. There were palpable lymph nodes in both inguinal regions. Roent-

easily but at about the middle of the transverse colon there seemed to be a complete obstruction caused by a large mass. A film showed an irregular, fine serration of the transverse colon distal

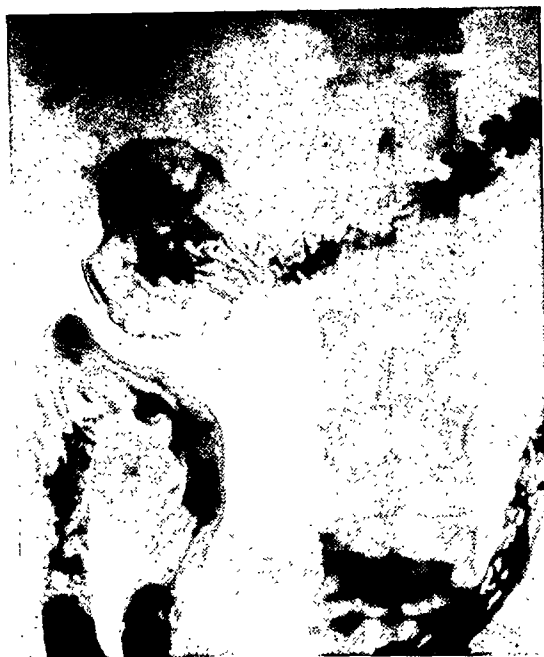


Fig. 4.

Fig. 4. Case 4. Post-evacuation mucosal film. Redundant sigmoid lies on the right side. There is a polypoid mass in the hepatic flexure. Gas and fecal material outline the ascending colon. The mucosal pattern of the transverse, descending, and rectal portions of the colon is well shown.



Fig. 5.

Fig. 5. Case 5. Excellent demonstration of the presence of barium between the stretched bowel plicæ giving the so-called "accordion-like" or "concertina-like" appearance. Proximal to this, dilated colon is outlined by gas and shows stretched circular plicæ. The serrated appearance of the colon distal to the intussusception has been described by Berg as indicative of mucosal edema.

genograms of the chest revealed a widened mediastinal shadow, apparently caused by a soft tissue-mass lying to the right of the aorta—possibly enlarged lymph nodes. Five days after admission, a firm, non-tender, and freely movable lump was felt just below the liver in the midclavicular line. One hour later this mass had moved to a point midway between the right upper and lower quadrants. Intussusception was suspected and roentgen studies were recommended. Abdominal films showed the presence of gas in the stomach and small intestine, on the left side of the abdomen, and in the pelvis. These findings suggested a bowel obstruction and a barium enema was attempted. The colon filled

to a large dilatation. The mid-portion of the transverse colon displayed an abrupt dilatation of bowel resulting in multiple, fine, transverse lines of barium, apparently lodged between the plicæ of the distended colon. The roentgen impression was invagination of the cecum and probably terminal ileum into the ascending and proximal transverse colon, and also infiltration of the remainder of the transverse colon, most marked just beyond the end of the intussusception (possibly secondary inflammation or edema).

At operation, the palpable mass was found to consist of huge, retroperitoneal glands lying in the upper portion of the right lower quadrant. Above this lay the

intussusception. It was not hemorrhagic or gangrenous, but all attempts at reduction failed. This mass was ileum which had progressed into the descending colon and was quite hard and nodular, suggesting the presence of a tumor. The entire mass was exteriorized in a first stage Mikulicz operation. Two days later the second stage was completed. The intussuscepted mass was removed with cautery and the ileostomy left open. Post-operative recovery was satisfactory and the patient was discharged in three weeks with a well-functioning ileostomy. The final pathologic diagnosis was round-cell sarcoma of the ileum causing intussusception. One month later the ileostomy was closed. No abdominal masses were found at this time. The patient has received roentgen therapy.

*Diagnosis.*—Round-cell sarcoma of the ileum with ileocolic intussusception.

*Comment.*—The film appearance of the colon in this case is interesting. The serrations of the transverse colon apparently were caused by infiltration of the bowel wall with tumor tissue. This type of haustration has been attributed by Berg (42) to diffuse mucosal edema. The "accordion" appearance of the dilatation, originally described by Muff (32), is due to barium caught between stretched plicæ. The roentgen evidence here is quite characteristic for intussusception.

#### CASE 6

U. M., a boy seven months of age, had passed several bloody stools three weeks previously. He was then apparently well until three days before admission, when the bloody stools reappeared, accompanied by abdominal soreness and vomiting. A barium enema was attempted, and, although the child had difficulty in retaining the enema, it was observed that the rectum, sigmoid, and distal transverse colon filled out normally. The barium was stopped in the transverse colon, forming a bulbous expansion with a cup-like depression in its center. The fluoroscopic evidence suggested intussusception, although from the film appearance of the colon all

that could reasonably be concluded was that the colon was obstructed by an intraluminal mass producing a convexity at the site of the obstruction.

At operation, a large mass was felt under the liver. The operation was then interrupted due to struggling during the change of anesthesia. Subsequently, when relaxation had occurred, the mass was very much smaller, and now lay in the right lower quadrant, undoubtedly the result of a partial reduction of the intussusception. This was about 10 cm. long and was easily reduced by pressure on the distal part until about one-half remained. Traction completed the reduction. It was then discovered that the intussusception was caused by an inverted Meckel's diverticulum which was very much indurated. This was everted; resection was decided against as too risky a procedure, and the abdomen was closed in layers without drainage. The patient made an uneventful recovery and was discharged the tenth post-operative day. He was last seen six years later at which time it was learned that he had been in excellent health.

*Diagnosis.*—Ileocolic intussusception with a Meckel's diverticulum.

*Comment.*—The roentgen findings are fairly typical for invagination; *i.e.*, obstruction, filling defect due to an intraluminal mass with its convex presenting surface, and cup-like depression in its center. The U-shaped configuration of the barium, emphasized by many authors, is not well shown on the film.

#### CASE 7

C. Mc., a 32-year-old truck driver, had been well until ten months previously when he experienced cramping low abdominal pain, usually after a bowel movement. One month later the pain became more frequent, almost daily in occurrence, and more severe. The patient's appetite gradually failed and he lost 15 pounds. Six weeks before admission he experienced his most severe bout of pain, lasting several hours. His stools had been normal in ap-

pearance. The clinical impression was that of an intracolonic neoplasm, and the patient was admitted to the hospital two days later for a more complete study. At this time, the lower abdomen was dis-

up toward the hepatic flexure, there was a rounded filling defect in the tip of the cecum, and the hepatic flexure was dilated by an intraluminal mass. After injection of air in double-contrast studies, barium



Fig. 6.

Fig. 6. Case 7. Post-evacuation film demonstrating the intussusception in the proximal transverse colon. Barium is present between the stretched plicae. The terminal ileum is filled.



Fig. 7.

Fig. 7. Case 7. Double-contrast film demonstrating the carcinoma of the cecum. The pressure of the air has been sufficient to completely reduce the intussusception.

tended and tympanitic. The ascending colon was palpable. Routine laboratory studies disclosed a moderate secondary anemia. Three out of 12 stool examinations gave positive benzidin reactions. On proctoscopic examination 14 cm. of rectum and sigmoid were visualized, and they presented a normal appearance. Detailed roentgen studies were made. The gall bladder, esophagus, stomach, and duodenal bulb were normal. With a barium enema the colon was observed to be redundant, and there was difficulty in filling the bowel beyond the hepatic flexure. The barium outlined an oval, palpable, but non-moldable mass. A film of the filled colon showed no lesion. A post-evacuation film excellently demonstrated the mucosal pattern of the colon. The cecum was drawn

again outlined a mass in the cecum, measuring about 6 cm. in diameter. There was barium in the terminal ileum. At a repeat colon fluoroscopy, the rectum and sigmoid filled easily. After the column of barium reached the splenic flexure, it met an obstruction which presented an oval appearance, convexly pointing toward the distal colon. As the enema was administered, this obstruction advanced proximally and the colon ballooned in a normal manner distal to the mass. As the barium reached the hepatic flexure, the colon filled with difficulty, but eventually barium passed the hepatic flexure. With the patient on his side, a definite area of decreased density surrounded by barium could be seen, measuring approximately 10 cm. in diameter. The mass noted previously in the

cecum could neither be palpated nor visualized. Apparently the intussusception was being reduced by the action of the enema. A post-evacuation film demonstrated a normal mucosal pattern of the ascending,



Fig. 8. Case 7. Post-evacuation films after the second examination. The intussusception has been completely reduced. The mucosal pattern of the lower ascending colon is distinctly abnormal. The carcinoma of the cecum is obscured by the filled terminal ileum.

transverse, and descending colon. The mucosal pattern in the cecum suggested edema, possibly also tumor infiltration. A double contrast film, after injection of air, yielded similar findings. There was no evidence of an intraluminal mass. These roentgen studies indicated severe intussusception of the cecum and ascending colon into the transverse colon, caused by an intraluminal mass, and recurring frequently. Administration of an enema served to overcome the distal part of the intussusception.

While being prepared for surgery the patient suddenly experienced a severe cramping pain with a bowel movement.

There was an abrupt descent of bowel through the anus for a distance of 15 cm. In the prolapsed bowel, a hard, irregular mass 6 cm. in diameter was discovered. Edema became very pronounced and the prolapse could not be reduced. The mass was excised under spinal anesthesia. The patient did not rally from the operation and died several days later. At autopsy it was learned that the terminal ileum, cecum, and ascending colon had invaginated into the transverse, descending, and sigmoid colon, and that the prolapsed bowel was cecum. Death resulted from obstruction with gangrene, perforation of the splenic flexure of the colon, and generalized peritonitis.

*Diagnosis.*—Intussusception of the terminal ileum, cecum, and ascending colon into the transverse, descending, and sigmoid bowel, with prolapse through the anus of 15 cm. of cecum containing a carcinoma.

*Comment.*—This case presented the most positive roentgen evidence of intussusception of the entire series: (1) Obstruction to the barium enema; (2) mobility of the obstruction under manipulation; (3) filling defect at site of obstruction; (4) palpable mass; (5) the passage of barium between the intussusceptum and intussusciens, outlining the "head" of the invagination.

The mucosal pattern of the cecum is interesting. It is difficult to state whether the appearance is due to edema (the result of irritation), or to tumor infiltration. Prolapse of an intussusception through the anus is not rare. In the monograph by Perrin and Lindsay it is stated that this occurred in 39.6 per cent of 400 cases. Many others have reported similar cases.

#### SUMMARY

A review of the literature on the roentgen diagnosis of intussusception has been presented. Seven additional cases have been described, illustrating various phases of the roentgen diagnosis. In all but one case, the intussusception was of the ileocolic type.

## CONCLUSIONS

1. The most frequently described roentgen signs of invagination are:
  - (a) Obstruction to the barium enema with a filling defect.
  - (b) Mobility of the obstruction under manipulation.
  - (c) Palpable mass.
  - (d) Passage of barium between the intussusceptum and intussusciptions.
2. The x-ray examination is a definite aid in the diagnosis of intussusception involving the large bowel.

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# EFFECT OF TREATMENT OF BRAIN TUMORS WITH ROENTGEN RAYS<sup>1</sup>

REVIEW OF UNIVERSITY HOSPITAL CASES

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## INTRODUCTION

A CONSIDERABLE amount of work has been done within the last ten years in an attempt to correlate the responses which have been observed in the irradiation of brain tumors. At present a variation of opinion is prevalent concerning the value of x-ray therapy in these conditions. Apparently good results following x-ray therapy have been questioned because of the known variation in the survival periods of the various types of brain tumors, because of known remissions and exacerbations in untreated cases, particularly the astrocytomas, and because it is difficult to say how much of the improvement was due to preceding surgery and how much to irradiation. The early papers on this subject attempted to interpret the value of irradiation therapy in the light of the clinical improvement observed, but because of the above-mentioned difficulties and the personal element involved, the investigations of the last ten years have been concerned chiefly with changes in the histopathologic picture of the various tumor types following x-ray therapy. This method of approach has been utilized by Davis and Weil (6), Deery (7), Frazier, Alpers, Pendergrass, and Chamberlin (11), O'Connell and Brunschwig (14), Alpers and Pancoast (1), Bailey, Sosman, and Van Dessel (2), and others.

The above-mentioned studies employed biopsy material obtained previous to x-ray therapy and that obtained at a later operation or at autopsy, for a purpose of comparison. The main histopathologic changes have been a reduction in cellularity of the neoplastic mass, an increase

in the amount of fibrous tissue and eventually fibrous replacement, a reduction in the total number of mitotic figures, and occasionally the appearance or increase in the number of giant cell forms. There is also a variable amount of vessel thickening which is considered by some as an essential feature and by others as a secondary change following irradiation.

Studied by this method Davis and Weil (6) found that medulloblastomas showed very little change, whereas Frazier, Alpers, Pendergrass, and Chamberlin (11) found a marked change. Clinically, this type usually shows marked improvement. These histologic variations may possibly be explained by the fact that the time intervals between irradiation and biopsy varied considerably. If the time were long enough a newgrowth arising from tumor remnants might conceivably mask a previous regression.

Spongioblastoma multiforme (glioblastoma multiforme) usually exhibit rather marked clinical improvement for a time. Sachs, Rubinstein, and Arneson (16) state that the average survival period for this group is from 10 to 14 months, if surgery alone is employed, and they present three cases which were given irradiation and survived for an average of 24 months. In the histopathologic studies it is very difficult to evaluate effects due to irradiation in spongioblastoma multiforme, as the structure of the neoplasm varies so markedly in different portions of the growth, and because the tumor during development may undergo changes similar to those which might be attributed to irradiation. Of six astrocytomas reported by Frazier, Alpers, Pendergrass, and Chamberlin (11) there was a very definite change noted in three. Of the three re-

<sup>1</sup> Read before the Minnesota Branch of the American Society of Cancer Research, Dec. 23, 1937.

maining cases which showed no change, only one had adequate treatment which these authors believe to be a tumor dose of over 2,000 r given at the rate of 200 r daily.

Reports have quite uniformly shown that ependymomas exhibit a marked histopathologic change together with good clinical improvement. Oligodendrogliomas show little or no histopathologic change, and there has been no recorded clinical improvement in this type except for one case reported by Sachs, Rubinstein, and Arneson (16).

Many workers have stated that there is no correlation between the amount of x-ray therapy given and the histological response observed. This is no doubt due to the fact that there has been such a great variation in the methods of treatment. As Frazier, Alpers, Pendergrass, and Chamberlin (11) pointed out, the correlation has been found to be high when the last series before biopsy or necropsy was considered instead of the total dose. While it is perhaps true that future advances in the treatment of cerebral neoplasms will probably come from histopathologic studies, the factors used in the different clinics have varied so widely up to the present that attempts to correlate separate reports would be futile. To make future studies of value all steps in treatment must be carefully standardized. As Deery (7) suggests, there must be—(1) Exact description of the location and size of the tumor; (2) exact statements as to the operative procedure; (3) standardization of pathologists' evaluation of malignancy; (4) general acceptance of adequate dosage and technic.

#### DISCUSSION

In a group of cases which have been reviewed at the University Hospital there has been no attempt to study the microscopic response since there were too few which had biopsies before and after irradiation, and in these the intervals differed considerably between the time of biopsy and

the time of irradiation; also, a considerable number of the biopsies were done elsewhere so that the tissue was not available for study here. We have tried to determine whether the favorable response obtained clinically in certain patients could be attributed wholly or chiefly to irradiation. We have not attempted to draw any conclusions from the series but merely present it to show the general response which has been observed in this clinic.

Treatment factors were as follows: 200 kv. peak voltage; 30 ma. current; filter 1 mm. Cu plus 1 mm. Al; 60 cm. T.S.D.; 10 × 10 cm. fields; half value layer 1.3 mm. Cu; output 27.2 r/min. measured in air. We have been giving 350 r every other day to one portal. Irradiation is given through from two to four portals depending on the location of the lesion until a total dose of 2,400 r has been given. This occasionally has been repeated up to five times, at two- to three-month intervals. Of the 44 cases to be described, 25 received but one course, and 12, two courses. Recently we have begun to give daily treatments of 160 r using the above factors and giving a total dose of 5,000 r over 27 days. This change has been instituted too recently to permit us to draw any conclusions from the results of this technic.

In the past ten years 74 patients have been treated in this therapy department, but only 68 could be checked as to their subsequent course. Of this number the diagnosis was proved by biopsy or necropsy in 44 cases. The median age for this group was 33 and the ratio of males to females was 2:1.

Of the 44 patients arranged in Table I, six, represented by the minus signs, died during or soon after treatment; since there was no time interval here in which improvement might have been observed, these were excluded from the discussion. It might seem that death was caused or hastened by irradiation in these cases. This was, for the reasons stated below, apparently not true. O'Connell and Brunschwig (14) state that there are two types of death which have been attributed to x-ray

therapy. The first is due to increased pressure where no preceding surgery has been done and in which the symptoms appear

TABLE I.—TUMORS OF CEREBRUM, CEREBELLUM, AND MENINGES; VERIFIED BY BIOPSY OR AUTOPSY

(Arranged according to the classification by Cushing, 3)

		Im- proved	Dead	Au- topsy
1. Gliomas				
Astrocytomas	13			
Fibular	2	0	2	1
Cellular	3-1	2	3	1
Cystic	1	1	0	0
Undifferentiated	7-2	5	6	1
Spong. multiforme	6	6	6	1
Medulloblastomas	1	1	1	0
Indeterminate type	5	3	3	2
Oligodendroglioma	1	1	0	0
Ganglion neuroma	1	0	0	0
2. Pituitary adenomas	Not included in this series			
3. Meningiomas	5-1	3	4	3
4. Acoustic tumors	1	0	1	0
5. Congenital tumors				
Teratoma	1	0	1	1
6. Metastatic and invasive tumors				
Melanoma	1	0	1	1
Sarcoma	1-1	0	1	1
Neurocytoma	1	0	1	1
Metastatic malign. or hemangio-endothelioma	1	1	1	0
7. Granulomatous tumors				
Tuberculoma	1	0	1	1
8. Blood vessel tumors				
Endothelioma	1	1	1	0
Angioblastoma	1	1	0	0
9. Primary sarcoma	0	0	0	0
10. Papilloma	1-1	0	1	1
11. Miscellaneous localized encephalitis	2	1	1	0
	44-6	25	35	15
	38			

(according to Bécélère) in one-half hour following treatment. The second type is preceded by no sign of increased pressure; the decompression remains soft and even flat or sunken. Such patients become listless, anorexic, and anemic. They gradually fail, and finally die in a cachectic state. In the above six cases, however, there was a preceding decompression performed in all but one; this latter patient was in a moribund state when treated and was treated only at the insistence of the surgical staff. Only part of the treatment was given and there were no following changes which might be attributed to a

sudden increase of pressure caused by irradiation. Of the remaining five patients, three died shortly from meningitis induced by preceding surgery. Regarding the second type of death without signs of increased pressure, there is no reason to believe that this might not also have occurred without roentgen treatment. One patient, not treated by x-ray therapy, went to just such a death six weeks after a preceding surgical excision which had been followed by temporary recovery. Further, it has been shown by Davis and Weil (6) that very little change has been noted in normal brain tissue following therapy for adjacent malignancies. Davis and Cutler (5) found that necrosis around radium needles implanted in canine cerebrums was limited to the areas immediately next to the needles and that this was not appreciably greater than the necrosis found around needles not containing radium element. Demel (8) produced deficient growth of the entire body, ataxia, and small hydrocephalic brains, in four-day-old puppies with irradiation of the brain, but Scholz (17) concludes that the brains of adult animals will withstand very high doses of x-ray. Elsberg, Davidoff, and Dyke (10) gave varying single doses to the brains and spinal cords of *Macacus rhesus* monkeys and concluded that any dose below 3,000 r was safe. In treatment of the human brain Sachs, Moore, and Furlow (15) have given as high as 6,000 r of unfiltered radiation directly to the brain through a craniotomy wound without noting untoward subsequent effects. Because of these reasons, x-ray therapy probably should not be blamed for the six above-mentioned fatalities in the series under discussion.

There was improvement of varying degree and for varying periods of time in 25 of the 38 remaining cases. It is evident, of course, that of the 25 histologically proved cases showing improvement it could not be determined whether the clinical gain should be credited definitely to surgery, irradiation, or to both. For that reason, certain cases have been grouped according to the surgery which was done in order to show



those in which the improvement was apparently due chiefly, or entirely, to roentgen therapy. The degree of improvement is self-explanatory: (1) refers to fair improvement, (2) to moderate improvement, and (3) to marked improvement, with nearly complete regression of symptoms.

The following cases are presented merely to illustrate the interpretation of such improvement.

Case 1. Degree 1. This patient was a white female, aged 37, with complaints dating from August, 1931, at which time she noted a definite decrease in her visual acuity. This progressed to complete loss of vision in June, 1932. During this time she had occasional attacks of vertigo and moderate frontal headaches.

She was admitted to the University Hospital on July 28, 1932. The pertinent physical findings at that time were bilateral optic atrophy with complete loss of vision, bilateral exophthalmos which was more pronounced on the left, and dilated pupils of equal degree. Blood and urine examinations were normal. The spinal fluid was under pressure of 350 mm. water, but was negative to examination. X-ray films of the skull showed destruction of the posterior clinoids which was interpreted as being due to an extrasellar neoplasm. Because of the complete loss of vision surgery was deferred and x-ray therapy given. This consisted of 940 r given to each of two fields in four treatments over a period of seven days. The patient was discharged Aug. 25, 1932.

Following treatment there was a temporary increase in the severity of the headaches and vertigo. This soon disappeared however, and for the next four years these symptoms were entirely absent. Her blindness was permanent, of course, but she stated that she generally felt much better following irradiation therapy. She worked daily and gained 40 pounds during the year following discharge.

In July, 1936, she experienced a sudden attack of convulsions and loss of consciousness. She recovered from this within a few minutes but in September developed

pain in the eyeballs and severe frontal headaches. On Sept. 17, 1936, she became comatose and was admitted to the hospital in this condition. Surgery was refused by the patient's family and x-ray therapy was begun as a last resort. She failed to rally, and died before the series was completed. An autopsy was obtained and revealed an extensive meningioma beneath both frontal lobes.

Case 2. Degree 2. This patient, a white male, aged 43, was admitted to the University Hospital on Feb. 24, 1932. He gave a history of irritability and headaches for three months, emesis for one and one-half months, constipation for one and one-half months, diplopia for three weeks, and a weight loss of 15 pounds in three months. Physical examination showed a somnolent individual who was mentally dull and who could not understand simple questions. There was a marked loss of memory, especially for recent events. The right pupil was larger than the left, and the left was sluggish to light. The disks showed bilateral choking and there were numerous punctate hemorrhages in both fundi. Definite paresis was exhibited in the right upper extremity and a loss of stereognostic sense was noted in both hands. The patient had an unsteady gait and the tendon reflexes were more prompt on the right side of the body.

A ventriculogram was done March 4 but was unsatisfactory. Following this procedure he was continuously comatose up to the time of operation on March 9. At that time a large tumor was found in the left frontal lobe which was resected as completely as possible. Microscopic section showed it to be a spongioblastoma multiforme. He was treated with x-ray on recovery from the surgical procedure and was given 650 r to each of two fields in four treatments. At the time of discharge on March 30 the findings were about the same as on admission.

An additional 550 r was given to each of two fields in April. On May 27, 1932, he was seen in the out-patient clinic. At that time he was feeling in excellent general

health. His mentality was clear, and his memory was perfectly normal. The eye grounds showed only one-half diopter choke on the right and one diopter on the left. There was only questionable slight paresis of the muscles innervated by the right fifth, eleventh, and twelfth cranial nerves. The patient could write without difficulty and the grip was equal in both hands. He was free from headaches and walked in a normal manner.

About the first of July he developed a partial aphonia and the right arm and leg became definitely weaker: 900 r were given to each of three fields with only slight improvement. The patient became progressively worse and died one month later.

Case 3. Degree 3. This patient, white male, aged 40, was first seen here in the dispensary in July, 1932, with a gastro-intestinal complaint which was diagnosed and treated as duodenal ulcer; at that time he stated that he had been having headaches in the supra-orbital region off and on for 18 months.

In the Fall of 1932 he began to complain of impaired vision and photophobia and increasingly severe headaches. His wife noted that his memory was becoming very bad. On October 6 he suddenly became comatose and was taken to the Mayo Clinic. At that time general and neurologic examinations revealed no positive findings except bilateral choked disks of two diopters and a partial third nerve palsy on the left side. The impression obtained clinically and from the ventriculogram was that he was suffering from a rapidly growing, deep-seated tumor. He was given a course of x-ray therapy and discharged from the Mayo Clinic much improved. He returned for examination in January, 1933, and was in excellent condition except for a bitemporal hemianopsia and only occasional slight headache.

He was admitted to this hospital on May 10, 1933, complaining of recurring headache, impaired vision, and paresthesias of his right arm. Neurologic examination showed a bitemporal hemianopsia and constriction of the nasal fields. The visual

acuity was  $\frac{3}{10}$  in the right eye and  $\frac{6}{10}$  in the left eye. There was a secondary bilateral optic atrophy and moderate external strabismus and limitation of conjugate movements upward. There was a moderate degree of deafness bilaterally, air conduction being greater than bone conduction. X-ray examination of the skull showed the trephine openings made during the previous ventriculography procedure, the floor of the sella turcica was markedly depressed, and the posterior clinoid processes were almost completely eroded. X-ray examination of the gastro-intestinal tract was negative. Diagnosis rested between an intrasellar or an extrasellar tumor. The patient was told that if his eyesight became worse operation might be attempted. He was re-admitted July 5 complaining of very severe headaches and requesting operation. Exploratory craniotomy was performed on July 15, at which time a soft, diffuse tumor mass was found arising from the right optic nerve. Biopsy alone was done and closure was effected. Subsequent microscopic examination showed the tumor tissue to be from an astrocytoma. He recovered satisfactorily from the operation and was given 850 r to each of three fields. He returned and was given a similar series beginning Oct. 30, 1933. At that time he was very much improved; his eyesight was better, there were no headaches, and he was able to be up and around most of the time.

On Jan. 18, 1934, he was seen in clinic. He was then feeling much better, was able to read the newspaper, and was working daily. In September, examination showed only slight constriction of the visual fields. There were only occasional slight headaches, and the memory was much improved. His next visit to the out-patient department was in September, 1935. At that time there was again noted marked improvement; his memory seemed normal, and he was working daily on his farm. He was again seen in March, 1936, at which time he was entirely symptom-free; visual acuity was  $\frac{20}{30}$  in the right eye and  $\frac{20}{30}$  plus 3 in the left; the fundi were normal

except for slight haziness at the nasal margins.

He continued to be neurologically negative for the next year and a half. He was admitted to the hospital on Sept. 16, 1937, with an abdominal complaint which examination showed to be due to a ureteral stone on the right side. Ophthalmoscopic and neurologic examinations revealed nothing abnormal. A ureterolithotomy was done Sept. 21, 1937, and the patient was discharged on Oct. 5, 1937.

In November, 1937, he was again seen in clinic and complained of bloating and some vomiting. Gall-bladder x-ray examination was negative, and the patient was put on an ulcer régime similar to that which had been employed in 1932.

Table II is self-explanatory except for the four following cases, which merit additional explanation. In the first case no surgery was done; the history and clinical course are described in the case representing first-degree improvement. It seems unusual that a meningioma should respond to irradiation, and such reports are few. However, Dyke (9) states that cases of fibroblastic meningiomas may respond, and de Luca (12) and Nordentoft (13) each reports a case of a meningioma with multiple involvement which responded well for a five-year period following x-ray therapy. There is also a case in our series in which a basal meningioma is suspected clinically, and which showed a very good response following therapy. When first seen, the chief symptom was frontal headache and disturbance of vision due to a marked unilateral exophthalmos. X-ray of the skull showed hyperostosis of the lesser wing of the sphenoid which was interpreted as due to an adjacent meningioma. The patient refused surgery and she is still living and in good condition, 40 months after irradiation therapy. The one patient in the third group, where x-ray therapy was given before surgery, showed marked improvement. In the fourth group, where decompression and biopsy alone were done because of apparent inoperability of the lesions, the first starred case represents a

patient who received a course of irradiation treatment before surgery was performed. There was about a second-degree

TABLE II.—CEREBRAL TUMORS PROVED BY AUTOPSY OR BIOPSY

Type	No. Mos. to Death or Living after Treatment		
	No. Mos.	Improve-ment	De- gree
1. No surgery			
Meningioma	36	1	D 51
2. Trephine only for Ventriculography			
Astrocytoma	24	2	L 27
3. X-ray before surgery			
Hemangio - endothelioma or met. malignancy	6	2	D 7
4. Decompression and biopsy only			
Spong. multiforme	5	2	D 9*
Spong. multiforme	3	3	D 4
Spong. multiforme	2	1	D 3
Glioma; indet. type	28	3	L 28
Astrocytoma	61	3	L 61*
Astrocytoma	8	1	D 26
Astrocytoma	25	2	D 32
Local encephalitis	10	1	L 46

improvement for a period of two months. At the end of this time a recurrence developed and surgery was done. The decompression procedure and another series of x-ray treatments were followed by similar improvement for an additional three months. The second starred case represents the patient described in the example for a third-degree improvement. In this patient there was marked regression of symptoms following irradiation before any surgery had been performed.

Twenty-one patients in whom the diagnosis of cerebral neoplasm was entirely clinical, were treated in this clinic. These are also arranged in groups in Table III to show possible clinical benefit from irradiation.

Table III is self-explanatory. The second patient in the second group was improved up to the time of death, which was caused by pneumonia.

There have been only six cases of proved cerebellar and four clinical cerebellar tumor cases treated here.

Of the six cases of proved cerebellar tumors, two died during, or immediately after treatment, and one died one month

after therapy without improvement. As in the cerebral tumors, there was no reason to believe that irradiation was a contribut-

It is better to represent the two cases starred in the clinical brain tumor group separately in Table V, since they may not

TABLE III.—CLINICAL CEREBRAL TUMORS

Position	Improve- ment		No. Mos. to Death or Months Living after Rad.	
	No. Mos. gree	De- gree	Living after Rad.	
1. Cases positive clinically, by skull plate and by ventriculography, no surgery performed				
Rt. ant. corpus callosum	71	3	L 71†	
Rt. frontal	2	1	L 18	
2. Cases positive clinically, skull plate non-localizing, no surgery, no ventriculography				
Rt. frontal	72	3	L 72*	
Basal lesion	44	2	D 44	
Mesencephalon	6	1	D 9	
Left third ventricle	7	2	L 10	
3. Surgery consisting of decompression and exploration, ventriculography positive in 1, 3, and 4				
Left third ventricle	4	2	D 37	
Rt. frontal	1	1	D 5	
Rt. temporal	1	1	D 3	
Rt. parietal	2	1	D 6	
Left frontal	1	1	D 2	
Pontine	18	3	L 18*	

† This case is now believed to be a cyst of the septum pellucidum.

TABLE IV.—CEREBELLAR TUMORS

Type	Improve- ment		No. Mos. to Death or Months Living after Treatment	
	No. Mos. gree	De- gree	Living after Rad.	
1. Those proved by biopsy				
(A) Decompression plus exploration				
Glioma; type indet.	95	2-3	D 95	
(B) Decompression plus resection				
Glioma; type indet.		3	Not Followed	
Medulloblastoma with spinal metastases	12-20	3	D 20-24	
2. Clinical cerebellar tumors				
(A) Decompression plus exploration				
Case 1	7	2-3	D 10	
Case 2	45	2	D 45	
Case 3	56	3	L 56	

ing cause of death. The patient in Division A of the first group was improved up to death, this being caused by carcinoma of the rectum. Of the four cases of clinical cerebellar tumors, one was a very questionable diagnosis (no surgery was performed), and the patient died two months after x-ray therapy without improvement. The third patient in the second group is now ten years old, is apparently completely well, and is attending school.

TABLE V

Position	Age	Clin.	Plain Film		Mos. Im- proved		Sur- gery
			Incr. Pr.	None	72	18	
Rt. Frontal	47	Pos.	Incr. Pr.	None	72	18	O
Pontine	24	Pos.	Incr. Pr.	Normal	72	18	D-E

be true cerebral neoplasms. They seem to belong to the type of cases which Dandy (4) has recently described as "intracranial pressure without brain tumor."

It will be noted that in both cases (Table V), the diagnosis was positive clinically. The plain film of the skull showed signs of increased pressure without localization. A ventriculogram was not done in one and in the other was entirely normal. Both showed marked improvement and are living at present, 72 and 18 months after treatment. No surgery was done in the first and only a decompression was done in the second. Dandy (4) has reported 22 cases in which a clinical diagnosis of brain tumor was made which was not substantiated by ventriculography. All of these patients had symptoms indicating an increase of intracranial pressure. In each case this pressure had been demonstrated and measured by ventricular or lumbar puncture. All plain films of the skull in his cases showed signs of increased intracranial pressure without localizing signs of tumor, and ventriculography in all revealed a normal ventricular system. Four cases in which the symptoms were minor were merely observed, and no treatment instituted. These four gradually improved without treatment and may correspond to the first of the two cases in Table V. Dandy's report is particularly interesting since it is evident that a certain number of brain tumors which have been diagnosed clinically but never verified by biopsy or autopsy may fall into this group where the symptoms and signs are an expression of pathologic conditions and not of brain tumors. It is possible,

therefore, that x-ray therapy was not a factor in the improvement in these cases.

#### SUMMARY

Fifteen of the 24 brain tumors diagnosed clinically showed improvement for periods varying from one to 72 months. It is quite possible that all 15 were aided by irradiation. Unfortunately this cannot be verified. However, it is quite certain that improvement in nine of the 15 was due chiefly to x-ray therapy. If the two cases discussed under intracranial pressure without brain tumor are excluded, the above number is reduced to seven; five of the seven showed either second- or third-degree improvement.

Twenty-five of the 38 brain tumors proved by biopsy or autopsy showed clinical improvement. As in the group diagnosed clinically it is likely that irradiation played a rôle in all 25 although this cannot be ascertained. There seems to be fairly definite evidence, however, that the improvement in nine of the 25 should be attributed chiefly or entirely to x-ray therapy. Of these nine, six showed either second- or third-degree improvement and four of this number are still living.

It is evident then that, regardless of the controversies regarding the value of x-ray therapy in the treatment of brain tumors, there are certain cases in which remarkable responses are obtained following its application, and presumably due to its effect. At present it is the opinion in this department that the dosage used in cases of brain tumor should be materially increased. Recently we have begun giving fractionated daily doses over a period of a month, resulting in a total dose of 5,000 r. Until the results from more intensive irradiation have been tabulated it will be difficult to predict the results.

This group of cases has been accumulated over a ten-year period and was not treated by the author. The records were perused by myself at the suggestion of Dr.

Wilhelm Stenstrom, who, together with William Peyton, M.D., kindly tendered much useful advice. The biopsies which were taken here were examined by either E. T. Bell, M.D., William O'Brien, M.D., or R. W. Koucky, M.D., and the surgery performed by William Peyton, M.D.

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# ROENTGEN DIAGNOSIS OF PREGNANCY<sup>1</sup>

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**A**TTEMPTS to employ roentgen rays in obstetrical diagnosis ensued almost immediately upon announcement of the discovery by Roentgen in 1895. At the outset, all efforts to secure roentgenographs of living fetuses invariably resulted in failure. However, coincidentally with progressive improvement in apparatus and consequent refinement of technic, chiefly by Albers-Schönberg in 1904 (1), Thoms in 1922 (16), Bouchacourt in 1923 (2), and Jungmann in 1927 (9), the application of roentgenology to obstetrics became general, presumably because of the recognition of its value as a source of accurate and dependable information in comparison to that supplied by ordinary methods.

Credit for the original demonstration of a fetal shadow by means of a roentgenogram is variously attributed to Levy-Dorn (10) and Müllerheim (11), who reported the results of their experiments a few months apart in 1897 and 1898, respectively.

Probably Warnekros (17) was the first investigator to succeed in obtaining roentgenograms of the living fetus during labor. His observations published in 1917 and 1918, subsequently served as a guide for his successors in their studies of the position of the fetus at the various stages of parturition.

For a long time it was feared that injury to fetus or mother might result from exposure to roentgen rays (4). This apprehension was fostered by accounts of post-radiative fetal and maternal injuries ranging from infantile alopecias to teratoses, and from still births to abortions. It was afterwards discovered that in these cases the radiation was therapeutic rather than diagnostic, and was applied in com-

paratively large doses for the treatment of conditions ranging from simple menorrhagia to cancer of the cervix. Actually, there is not the slightest evidence that antenatal exposure to roentgen rays for purposes of diagnosis is at all harmful to the fetus or mother.

In his excellent monograph on roentgenography as an aid in obstetrical diagnosis published in 1931, Jarcho (8) presented a survey of the literature to that date. This showed that among 95 cases of suspected pregnancy subjected to roentgenographic examination, 61 reported by Warnekros and 34 reported by Dijol and Michelin, the presence of a fetus was clearly demonstrated in 64 cases in the fourteenth to the twentieth week of pregnancy, while in 31 cases no fetal skeleton was visualized. The literature to 1931 revealed 15 cases of anencephalus diagnosed roentgenographically.

Roberts (12), in 1932, related his experience with 600 cases in which a roentgen examination was undertaken at the request of an obstetrician, either because of clinical suspicion of abnormality, or to supplement ordinary methods of examination. In his series, twins were demonstrated in 84 cases, and triplets in one instance. Of three cases of extra-uterine pregnancy included in the series, two were diagnosed roentgenologically. Anencephalus was shown in 17 cases, hydrocephalus in six, iniencephalus in three, meningocele in one, and rudimentary upper limbs in one. Of 16 cases of intra-uterine death involved in the series, Spalding's (14) sign was positive at the first roentgen examination, in nine cases.

Unlike the Aschheim-Zondek and other analogous tests for pregnancy which require several days (from 96 to 100 hours) for their effective application, and even then afford only presumptive evidence,

<sup>1</sup> Read before the Washington Gynecological Society, March 26, 1938 (by invitation).

roentgenography renders possible an immediate positive opinion as to the existence or non-existence of pregnancy. In addition, it facilitates the differential diagnosis between the latter condition and hydatidiform moles and abdominal and pelvic tumors in obscure cases, and determines the position and presentation of the fetus when there is doubt concerning these aspects. In still other instances, roentgenography permits a decision as to the presence of more than one fetus, and the possibility of extra-uterine pregnancy. Again, it provides an opportunity for the investigation of the cause of hydramnios, with particular reference to fetal abnormalities, serves for the detection of placenta prævia, and aids in the diagnosis of intra-uterine death. Finally, it enables the assessment by means of pelvimetry of the precise measurements of the pelvic brim or outlet in a case of suspected contracted pelvis, and the verification of suspected disproportion between the fetal head and the maternal pelvis.

In certain cases previously reported with clinical findings markedly indicative of fibroids and other conditions simulating pregnancy, a positive diagnosis of pregnancy was established by roentgenography, and an unnecessary hysterectomy was thus avoided.

Roentgenographs in two planes (anteroposterior or postero-anterior, and lateral) invariably furnish precise and reliable information concerning the presenting part, and the relation of the fetal parts to each other and to the maternal pelvis and spine, thereby enabling the estimation of the degree of flexion of the head in vertex presentations, and of flexion or extension of the lower limbs in breech presentations.

In cases of multiple pregnancy, roentgenographs disclose the relative position of the fetuses to one another and to the maternal parts. Twins may often be demonstrated roentgenologically, even when undetected by previous clinical examination. Also, in hydramnios, when a tentative diagnosis of multiple pregnancy

has been made clinically, the presence of only one fetus is frequently shown.

Extra-uterine pregnancy is revealed whenever any of the fetal parts are observed to extend beyond the shadow of the uterus. If the latter is not demonstrable in suspected extra-uterine pregnancy, uterosalpingography may be resorted to by injecting lipiodol into the uterine cavity and taking a roentgenograph. The shape of the filled cavity and its relation to the fetal shadows will afford the desired information concerning the extra- or intra-uterine site of the pregnancy. However, if this procedure is elected, there should be the closest co-operation between the roentgenologist and the obstetrician, since only the latter can determine whether the use of the method is warranted; and termination of a pregnancy without sufficient indication is a reprehensible act.

Uroselectan is employed as a contrast medium in amniography when the latter is utilized for the discovery of a placenta prævia. The substance is injected through the abdomen into the amniotic sac, following the withdrawal of an equivalent quantity of amniotic fluid. The use of uroselectan is open to objection from the clinical point of view by reason of the fact that its injection inevitably results in the termination of pregnancy. Another method for the same purpose, applicable only in the latter months of pregnancy and to vertex presentations, consists of visualization of the bladder after filling it with 12.5 per cent solution of sodium iodide—the translucent interval between the fundus of the bladder and the fetus appears greater than normal in placenta prævia. Cystography is simple, safe, and involves no risk of abortion, but it is inapplicable to cases of lateral and posterior placenta prævia, since the presence of a central clot often entails misinterpretation of the roentgenographs.

Intra-uterine death is indicated by the roentgenological sign originally described by Spalding (14), characterized by collapse of the vault, which in turn, results from shrinkage of the brain and produces

overlapping of the cranial bones. This phenomenon should be carefully differentiated from the normal overriding or molding which occurs during labor.

In his recent masterly article on roent-

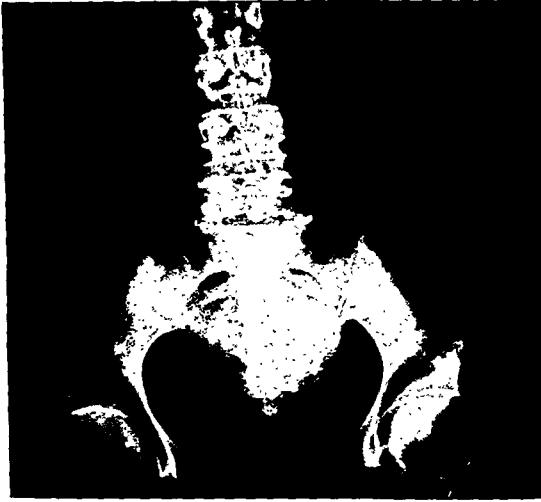


Fig. 1. Early pregnancy. Duration 61 days or less.

genography in obstetrics, Jacobs (7) presented a most complete description and sound evaluation of the several methods of roentgen pelvimetry; hence their consideration and the discussion of their respective merits need not detain us here.

Although absolute measurements of both the maternal pelvis and the fetal head constitute our objective, that of the former are by far the more important, since it should ever be borne in mind that the birth canal is a tortuous fixed passage, while the fetus is an adaptable passenger. However, by means of roentgenographs taken in the postero-anterior, antero-posterior, and lateral projections, a fair idea of the allowance for relative enlargement of the skull and pelvis due to their different distances from the films may be obtained.

The roentgenologist has at his disposal two criteria on which to base an estimate of the duration of the period of gestation and the corresponding age of the fetus; namely, the size of the fetus, and the stage

of ossification of its bones. Since the size of the fetus varies with the target-fetus-film distance, a standard technic should be maintained for the establishment of a standard of comparison of sizes of fetuses at different ages. Unless this distance is known, the size of the fetus cannot be gauged from the size of the image on the film. Even so, under the most favorable conditions different parts of the fetus will be situated at varying distances, consequently an accurate orientation is impossible. In addition to the roentgenographic size of the fetus, other factors (hydramnios or multiple pregnancy, for example) which may affect its relative distance from the film and the resultant enlargement of its roentgenographic shadow, should be considered.

The method of the determination of the stages of ossification is likewise unreliable, inasmuch as the dates of appearances of the various osteogenic centers are not precisely fixed. Embryological studies show that from the thirtieth day of fetal life osseous centers begin to appear, at first with marked constancy and predilection in certain bones, and shortly afterward they are observed everywhere in the cartilaginous structure of the fetus.

Initial points of ossification appear in the inferior margin of the mandible (Meckel's cartilage), and in the diaphysis of the clavicle from the thirtieth to the thirty-fifth day, and the first cartilaginous islets are invariably noted in these two skeletal sites. Ossification points appear in the tibial diaphysis from the thirty-fifth to the fortieth day, and from the fortieth to the fiftieth day in the frontal (orbital arches), parietal (parietal protuberances), and palatine bone, in the vomer, and at several points in the inferior maxilla (except the symphysis adjacent to the mental foramina, condyles, coronoid apophyses, and the lingula mandibulæ).

Next follow in order the costal diaphyses, the squama and the scapular spine, the humeral diaphyses, the radial diaphysis, the iliac bones, diaphysis of the fibula, and diaphyses of the first phalanges. From



the second to the third month new ossification points appear in the frontal (nasal spine, external orbital apophyses, trochlear fossettes), occipital (basilar apophysis, condyle, squama), temporal (squama, pet-

mass in order to become opaque to roentgen rays. The chronological order of appearance of the different centers is, however, essentially the same with histologic and roentgenologic methods of observa-



Fig. 2.

Fig. 2. Early pregnancy.  
Fig. 3. Early pregnancy.



Fig. 3.

Duration 89 days or less.  
Duration 90 days or less.

rous, mastoid apophysis), superior maxilla (malar margins, nasal orbit, nasal, palatine, subvomerine), malar bone (zygomatic portion and orbital portion), in bones proper of the nose, the posterior atlantic arch, the epistropheus, the last five cervical vertebræ, the cubital diaphysis, diaphyses of the metacarpal bones, femur, and metatarsal bones.

Finally, during the fourth to the fifth month, ossification points appear in the ethmoid, alæ and apophyses of the sphenoid, body and alæ of the sacrum, ischium, and calcaneus.

Differences in dates of appearance of centers of ossification from the viewpoint of the roentgenologist, in contrast to that of the histologist and embryologist, are due to the fact that ossification points must have first attained a sufficiently compact

tion. The latter also demonstrates that the clavicle as well as the mandible exhibits the first osseous points revealed by the roentgen rays.

Among pediatricists, Hess (6), who conducted his experiments on fetuses *in vitro*, asserts that initial points of ossification are demonstrable on films as early as the seventh week, while in the eighth week there may be described the appearance of numerous points corresponding to the squamous portion of the occipital bone, superior maxilla, scapular spine, humerus, radius, ulna, femur, and ribs. In the ninth week the metatarsal and metacarpal centers appear, and are followed gradually by centers of ossification of cervical and first dorsal vertebræ, sphenoid, malar bone, other bones of the head, and finally the ilium. In the tenth week there are

menstrual period, Aug. 20, 1936; contact, Sept. 3, 1936; roentgen study, Nov. 3, 1936. I am not in entire agreement that this case does not exceed 61 days. Repeated interrogation failed to alter the

roentgen study, Sept. 1, 1936. Personal factors in this case insure accuracy of dates. The osseous development is not inconsistent. Position prone.

Case 5. A pregnancy of 95 days or less



Fig. 7.

Fig. 7. Collapse of skull vault (Spalding's sign), six days, overlapping of *anterior* fontanelle.



Fig. 8.

Fig. 8. Collapse of skull vault (Spalding's sign), six days, overlapping of *posterior* fontanelle.

patient's statement regarding dates, concerning which she was definitely positive. (Courtesy J. M. Keichline, M.D.) Position supine.

Case 2. A pregnancy of 89 days or less (Fig. 2). The dates are accurate, and the skeletal development is consistent. The position was prone, with pressure on the buttocks. (Courtesy William J. Corcoran, M.D.)

Case 3. A pregnancy of 90 days' duration or less (Fig. 3). The last menstrual period was March 12, 1936; contact, March 20, 1936; roentgen study, June 18, 1936. The dates are accurate, and fetal development consistent. Position supine.

Case 4. A pregnancy of 93 days or less (Fig. 4). The last menstrual period was May 16, 1936; contact, May 31, 1936;

(Fig. 5). The last menstrual period was Oct. 24, 1936; contact, Nov. 1, 1936; roentgen study, Feb. 27, 1937. The dates are correct. Position prone.

Case 6. Collapse of the skull vault with overlapping at the anterior fontanelle (Spalding's sign of fetal death) is shown in Figure 6. The interesting feature of this case is that studies made at weekly intervals following cessation of fetal movements and heart sounds did not reveal signs of death until the fourth study, made on the thirty-first day. Some days later spontaneous labor ensued, and a markedly macerated and old fetus delivered. Position prone.

Case 7. Collapse of the skull vault with overlapping at the anterior fontanelle six days after the cessation of fetal movements

and fetal heart sounds is shown in Figure 7. The following day spontaneous labor began, and a slightly macerated fetus was delivered. Autopsy of the infant showed a central separation of the placenta which

monster (Fig. 9). The last menstrual period was Dec. 9, 1936. The expected date of confinement was Sept. 16, 1937. Delivered, Aug. 6, 1937. Diagnosis confirmed. Position prone.



Fig. 9. Anencephalus.

was undoubtedly the result of a rather violent fall which immediately preceded the cessation of fetal movements and heart sounds. Position prone.

Case 8. The same case as Case 7, with overlapping at the posterior fontanelle (Fig. 8). Both roentgen studies were made at the same sitting, and the inference is drawn that shrinkage is advanced in the intracranial contents. Position prone.

Case 9. This was an anencephalic

#### COMMENT

The absolute diagnosis of pregnancy, that is, the demonstration of a recognizable fetal skeleton, can be accomplished routinely from the twelfth week onward, and occasionally earlier. From available evidence it appears that the diagnostic use of the roentgen ray is not deleterious to either mother or fetus.

The duration of pregnancy in the cases

presented is determined by taking the last normal menstrual period as evidence that the patient was not pregnant. The date of first contact following the last normal period is used as a date prior to which the patient could not be with child. The number of days from this date, to the date of roentgen study, is considered as the number of days of the pregnancy.

It is obvious that while no case exceeds this number of days, many are considerably less if we accept the statement of Willson (18): "Counting the first day of your menstrual period as one, you are sterile beginning on the twentieth day, and remain so up to and including the seventh day after the beginning of your next menstrual period." In the cases presented, only patients who are positive of dates are used. The unreliability of Spalding's sign is demonstrated by the two cases presented, the first case of which was demonstrated six days after the cessation of fetal movements, and the second case in which 31 days were required before the sign was positive.

We believe that the technic in the production of films is of the greatest importance. Sufficient time should be taken with the patient so that she is not unduly excited. A practice exposure or two should be made by running the Potter-Bucky diaphragm so that the patient will understand and thoroughly comprehend the length of time it will be necessary to hold the breath. It is our custom to have the patient take a cleansing enema several hours prior to reporting for examination. Regular-speed screens and Potter-Bucky diaphragm are used. The positions are postero-anterior and anteroposterior, that is, face down and face up. The prone position, that is, the postero-anterior or face down, has been the most successful. The lateral view has not been of value in early cases. We have never been able to demonstrate a fetus in the lateral view that could not be demonstrated in the postero-anterior or anteroposterior views. The voltage factor is variable, from 65 to 85

kv.p., 60 ma. of current, 25-inch distance for 1 second. Compression is not used routinely. If roentgenographic cones are employed, the use of the 8-inch size is recommended for  $10 \times 12$  films and the 5-inch size for  $8 \times 10$  films. Several films should be exposed at each sitting, and the studies made at weekly intervals from the eighth week. It is our impression that if we cannot demonstrate a fetal skeleton by the fourteenth week, the patient is not pregnant.

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## LYMPHOBLASTOMA WITH SIGNS OF RENAL INVOLVEMENT IMPROVED BY ROENTGEN THERAPY: REPORT OF THREE CASES<sup>1</sup>

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THE three cases reported herein are presented because of the unusual complication in connection with lymphoblastoma. Each of the patients showed signs of definite renal insufficiency which decreased with roentgen therapy to the renal areas (Table I).

The explanation for the striking improvement in the renal function of our three patients is not entirely clear. The symptoms and findings may have been obstructive phenomena and, therefore, spontaneous improvement followed shrinkage of the lymphoblastomatous tissue by radiation therapy with subsequent relief of obstruction. A second possibility is that the symptoms were caused by infiltration or direct extension of the disease into the kidneys and that they improved subsequent to irradiation over the kidneys themselves. A third possibility is that retrogression of the diffuse disease process by roentgen therapy may have brought about remission of a toxemia secondary to lymphoblastoma, with partial or complete restoration of normal renal function.

### REPORT OF CASES

Case I, a woman, 21 years of age, first registered at the Clinic on July 9, 1936. She had been well until three years previous to admission, at which time she had had intermittent attacks of watery diarrhea for three to four months. In October, 1933, a mass had been discovered in the left posterior cervical region and the patient was found to have a mild anemia. Early in 1934 weakness, malaise, and easy fatigability developed. The mass in the neck gradually increased in size and was excised in June, 1934, at which time a diagnosis was made of Hodgkin's disease.

About 18 months prior to her first admission to the Clinic, the patient noticed a rise in temperature to from 101° to 102° F. each evening but it always dropped to normal by the following morning. Six months previously, a widening of the mediastinal shadow had been noted in the roentgenogram of the thorax and she had been given three roentgen treatments over the chest. She had been in bed for six weeks before coming to the Clinic, because of weakness, photophobia, anorexia, nausea, and vomiting. She had lost 22 pounds (10 kg.) in weight in the six months previous.

On physical examination at the Clinic, the patient's blood pressure was 92 mm. of mercury systolic, and 60 diastolic, her temperature 99.2° F., and her pulse rate 110 beats per minute. The cervical, axillary, and inguinal lymph nodes were enlarged bilaterally. Percussion of the chest revealed no increase in mediastinal dullness. A firm tender mass was palpated in the right upper quadrant of the abdomen. Enlargement of the spleen could not be demonstrated by palpation. Urinalysis revealed nothing of significance except pus (grade 1). A diagnosis of Hodgkin's disease was made and a thorough course of roentgen treatment was given. Three courses of roentgen treatment were applied to regions of involvement between July, 1936, and January, 1937. Her general health improved and she gained considerable weight.

In March, 1937, the patient returned with the complaint that five days before admission she had noted bilateral edema of the ankles which had become progressively worse. There were no cardio-respiratory, gastro-intestinal, nor genito-urinary symptoms. Physical examination gave negative results except for the demonstration of palpable retroperitoneal lymph

<sup>1</sup> Submitted for publication July 12, 1938.

nodes and pitting edema of the legs, ankles, and abdominal wall. The urine contained albumin (grade 3), erythrocytes (grade 1), and pus (grade 1). The concentration of serum protein was 3.8 gm. per 100 c.c. and the albumin-globulin ratio was 1:2.2. The patient was hospitalized, placed on a high protein (120 gm. daily), low salt diet, given one intravenous injection of 5 per cent acacia (500 c.c.) and two roentgen treatments. On this therapy the edema improved somewhat. Following her return home, the edema of the extremities again increased. On May 8, 1937, a sudden precordial pain developed which was accentuated by respiration and was accompanied by a temperature of 102° F. A diagnosis of pericarditis was made. The following day herpes zoster developed over the right side of the chest.

The patient returned to the Clinic May 23, 1937, complaining of persistent edema of the extremities and profound exhaustion. Physical examination revealed bilateral hydrothorax, the involuting lesions of the recent herpes zoster, a palpable right kidney, and edema of the extremities. On urinalysis albumin (grade 3), casts, occasional erythrocytes, and pus (grade 1) were found. The values for the serum protein and albumin-globulin ratio had not altered appreciably since March, 1937. She received a course of roentgen treatments over both renal regions and at the time of her dismissal on June 8, 1937, the edema had disappeared and she was much improved symptomatically.

Subsequent roentgen treatment was given in July, August, and September, 1937, to regions of recurrence, but there has been no return of renal symptoms. In July, urinalysis gave negative results except for pus (grade 2).

Case II, a man, aged 62 years, first came to the Clinic Aug. 24, 1936. He had had an acute infection of the upper part of the respiratory tract in January, 1936, and one week later albumin, casts, and pus cells were found in the urine. In February, 1936, vertigo, weakness, and fre-

quent headaches over the vertex developed. Phenolsulphonphthalein test revealed excretion of 31 per cent of the dye in two hours. A diagnosis was made of acute nephritis. By April, 1936, the urine had become normal but the patient continued to feel weak. Two weeks before admission an enlarged spleen was discovered, a diagnosis of splenic anemia was made, and splenectomy was advised. He had lost 25 pounds (11.4 kg.) in weight in the two years previous.

On physical examination at the Clinic the patient's weight was 156 pounds (70.9 kg.). The heart and lungs appeared to be normal. The spleen could be palpated 5.5 cm. below the left costal margin and was slightly tender. Examination of the ocular fundi gave negative results except for anemia of the optic disks. Urinalysis revealed albumin (grade 2), casts, erythrocytes (grade 3), and pus (grade 1). The value for blood urea was 76 mg. and for serum sulphates 5.8 mg. per 100 c.c. The urea clearance was 20.5 c.c. (normal 60 c.c.) and the sulphate clearance was 16.2 c.c. (normal 20 c.c.). An excretory urogram revealed evidence of right hydronephrosis with the function of the right kidney reduced a third, and moderate pyelectasis in the left kidney with little or no diminution in function. A roentgenogram of the thorax revealed a circumscribed shadow at the level of the sixth and seventh ribs posteriorly on the left. This was suspected of being either a primary malignancy of the lung, or a metastatic lesion from a possible renal neoplasm. A lymph node from the left cervical region was excised and a diagnosis was made of lymphosarcoma. The patient received a course of roentgen treatment over the chest, abdomen, and inguinal nodes and was dismissed with instructions to follow a nephritic regimen.

The patient returned in October, 1936, stating that he had had a severe infection of the upper part of the respiratory tract with a temperature of 103° F. one week before. He also complained of frequent right occipital headaches, weakness, ex-

## ODEL AND POPP: LYMPHOBLASTOMA

TABLE I.—LYMPHOBLASTOMA WITH SIGNS OF RENAL INVOLVEMENT IMPROVED BY ROENTGEN THERAPY: LABORATORY DATA

Case	Date	Urine					Blood									
		Specific gravity	Albumin, grade	Casts, grade	Red cells, grade	Pus cells, grade	Hemoglobin, gm. per 100 c.c.	Erythrocytes, million per cu. millimeter	Leukocytes, per cubic millimeter	Urea, mg. per 100 c.c.	Urea clearance	Sulphates, mg. per 100 c.c. serum	Sulphate clearance	Cholesterol, mg. per 100 c.c. plasma	Protein, gm. per 100 c.c. plasma	Albumin-globulin ratio
I	July, 1936 <sup>1</sup>	1.010	0	0	0	I	12.1	4.65	14,700					250.0	3.8	1:2.2
	Mar., 1937 <sup>1</sup>	1.017	3	0	I	I	14.0	4.00	11,100						3.3	1:3.2
	May, 1937 <sup>1</sup>	1.020	3	+	occ	I	14.8	4.15	10,800							
	July, 1937 <sup>1</sup>	1.012	0	0	0	II	11.6	4.27	9,600							
	Aug., 1936 <sup>1</sup>	1.018	2	+	III	I	11.4	3.84	7,100	76.0	20.5 c.c. (vol. 150 c.c.)	5.8	16.2 c.c.	175.0	5.8	
II	Oct., 1936	1.013	2	0	II	IV	10.7	3.55	7,900	86.0	21.8 c.c.	6.3	17.0 c.c.			
	Jan., 1937	1.009	1	0	0	0	13.6	4.24	5,600	64.0	41.6 c.c. (vol. 200 c.c.)					
	Apr., 1937	1.005	0	0	occ	0		3.97	5,900	40.0		4.4	22.0 c.c.			
	Jan., 1938	1.027	1	0	0	0	14.4	3.88	6,200	42.0						
	Aug., 1937 <sup>1</sup>	1.023	4	+	occ	I	10.3	3.46	4,900	48.0	26.7 c.c. (vol. 96 c.c.)	12.8	5.9 c.c.	303.0	5.0	2.3:1
III	Sept., 1937	1.025	3	0	occ	0	12.1	3.86	3,000	26.0	49.9 c.c. (vol. 110 c.c.)	3.7	26.1 c.c.		5.5	
	Nov., 1937 <sup>1</sup>	1.005	0	0	0	0	10.3	3.70	5,200	26.0	62.0 c.c.					
	Jan., 1938 <sup>1</sup>	1.030	1	0	0	I	12.3	3.71	6,200	30.0	64.4 c.c. (vol. 35 c.c.)	4.6		245.0	6.7	3.2:1

<sup>1</sup> Roentgen therapy.

haustion, and some burning on urination. His weight was 156 pounds (70.9 kg.). Physical examination revealed a few fine moist râles at the base of each lung and a few small, firm, cervical lymph nodes. The spleen was barely palpable beneath the left costal margin. There was marked tenderness to palpation and percussion in the right lumbocostal region. The urine contained albumin (grade 2), erythrocytes (grade 2), and pus (grade 4). The concentration of blood urea was 86 mg. and of serum sulphates 6.3 mg. per 100 c.c. A roentgenogram of the thorax disclosed nothing abnormal. Cystoscopic examination and ureteral catheterization revealed cloudy urine from the right kidney. A diagnosis was made of right pyelonephritis. Following his return home the pyelonephritis became severe but the attack subsided in about two weeks.

When the patient returned in January, 1937, he had gained 25 pounds (11.4 kg.) in weight and was free of symptoms. Physical examination gave negative results and the spleen could not be palpated. He returned in April, 1937, for re-examination. His general health was excellent; his weight was 179 pounds (81.4 kg.) and physical examination gave entirely negative results. Urinalysis revealed nothing abnormal except for occasional erythrocytes. The concentration of blood urea was 40 mg. and of serum sulphates 4.4 mg. per 100 c.c. Urea clearance had increased to 41.6 c.c. and sulphate clearance to 22 c.c. While at the Clinic herpes zoster developed which subsided under treatment with intramuscular injections of whole blood and local applications of calamine lotion. His most recent examination in January, 1938, revealed him to be in perfect health and without complaints. His weight was 183 pounds (83.2 kg.).

Case III, a man, aged 41 years, came to the Clinic on Aug. 28, 1937. Two years previously, he first noticed slight loss of weight, and fatigability. Six months later he noticed enlarged lymph nodes in the left inguinal region, fol-

lowed by enlargement of the nodes in both cervical regions and in the right inguinal region. Two weeks before admission he had noticed marked edema of the ankles and puffiness around the eyes and face. The urine at this time was apparently normal. Urinalysis one week later revealed albumin. The patient was also found to have a moderate anemia. He had lost 20 pounds (9.1 kg.) in weight in the two years previous.

On physical examination at the Clinic the patient was found to have a definite pallor. His weight was 134 pounds (60.9 kg.). There was diffuse enlargement of all regional lymph nodes. Examination of the nasopharynx, heart, lungs, abdomen, and rectum gave negative results. There was pitting edema of the pretibial regions and ankles (grade 1). A lymph node was excised from the right cervical region and a diagnosis of lymphosarcoma was made. The urine contained albumin (grade 4), casts, occasional erythrocytes, and pus cells (grade 1). The concentration of blood urea was 48 mg. and of serum sulphates 12.8 mg. per 100 c.c. The urea clearance was 26.7 c.c. (normal 40 c.c.) and the sulphate clearance 5.9 c.c.

A course of roentgen treatments were given over the regions of definite involvement but because of the renal complication additional treatment was given over both renal regions. After treatment urinalysis revealed albumin (grade 3) and occasional erythrocytes. The concentration of blood urea had dropped to 26 mg.; that of serum sulphates to 3.7 mg., and the results of urea and sulphate clearance tests were normal. The patient was dismissed with instructions to take a high protein diet and a limited quantity of salt. During the ensuing two months the patient gained 12 pounds (5.4 kg.) in weight, regained his appetite, and noticed a marked improvement in strength.

In November, 1937, his condition was checked elsewhere. Results of tests of renal function at that time were entirely normal. Roentgen treatments were given for the recurrent adenopathy in both



cervical and inguinal regions and the left axilla. The patient returned to the Clinic in January, 1938, complaining of anorexia, nausea, diarrhea, fatigue, and loss of 6 pounds (2.7 kg.) in weight in three weeks. On physical examination his weight was 134 pounds (60.9 kg.) and pallor was evident. There were palpable, firm, shotty, cervical, supraclavicular, axillary, and epitrochlear lymph nodes. Examination of the heart revealed a loud apical systolic murmur, but the lungs appeared to be normal. Examination of the abdomen gave negative results except for tenderness (grade 1), in the midabdomen on the right. Rectal examination was negative.

Roentgenograms of the chest, kidneys, ureters, bladder, and colon showed nothing abnormal. Roentgenograms of the stomach revealed a duodenal ulcer and analysis of the gastric content showed achlorhydria. Urinalysis revealed nothing abnormal except for albumin (grade 1) and pus (grade 1). The values for blood urea and serum sulphates and results of the urea clearance test were normal.

The patient received roentgen treatment over the regions of involvement and was instructed to follow an ambulatory ulcer program and to take liver and iron for his anemia.

#### COMMENT

Edema, albuminuria, hematuria, pyuria, and other evidences of disturbed renal function have been reported in numerous cases of lymphoblastoma. Edema may result from involvement of blood vessels or lymph vessels by lymphoblastoma of the inguinal, iliac, or para-aortic lymph nodes, or it may be attributable to toxic involvement of the kidneys with secondary derangement of the metabolism of water and inorganic substances giving rise to a clinical picture simulating a nephrotic syndrome. Not infrequently in lymphoblastoma, especially when abdominal nodes are involved, one or both ureters may be obstructed with a resultant hydronephrosis and, in some cases, pyelonephritis.

Whether the kidneys are involved by infiltration, by direct extension, or by metastatic invasion is a debatable question. Mallory (1) stated that lymphoblastoma rarely infiltrates the kidneys. Scribner (2) reported a case in which, at necropsy, the kidneys were diffusely infiltrated with lymphoid tumors. In Knutti's (3) case of primary lymphoblastoma of the thymus gland, the only discoverable metastasis was to the kidneys. Simonds (4) stated that deposits of lymphoblastoma in the kidneys are almost always associated with involvement of the retroperitoneal nodes. Cutler (5) reported a case in which the upper portion of the left kidney was involved in a huge retroperitoneal mass which included the pancreas and was attached to the upper lumbar vertebræ.

Labbé and Balmus (6) reported a case of lymphoblastoma with retroperitoneal involvement and extension to the kidneys. Their histologic sections of the kidneys revealed nodular accumulation of lymphoblastomatous tissue, areas of diffuse infiltration, some glomerulitis, tubular compression, and fibrosis.

Among a group of patients dying from lymphoblastoma, Barron (7) found the cortices of the kidneys swollen, cloudy, and pale and it was his belief that these findings represented an acute toxic nephrosis. Boles (8) found the tubular epithelium swollen and many of the tubular cells vacuolated. Messick and Furrer (9) stated that parenchymatous degenerative changes, apparently due to toxemia, as found in lymphoblastoma, may explain the renal insufficiency not infrequently associated with the disease.

As we have stated, the nature of the fundamental derangement in renal function underlying the clinical picture in the foregoing cases, and the explanation for the striking improvement under roentgen therapy to the renal regions are not clear. However, the rate at which improvement occurred in these cases corresponds so closely to the known rate of improvement

in lymphoblastoma that the association is almost inescapable.

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## PALLIATIVE RESULTS IN RADIATION THERAPY OF ADVANCED CARCINOMA OF THE CERVIX<sup>1</sup>

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**K**INGS County Hospital is a general hospital with approximately 3,000 in-patients and a large out-patient department. It is one of the associated hospitals of the Department of Hospitals, City of New York. The radiation therapy service in Kings County Hospital is a unit of the cancer service of the department of hospitals. The in-patient cases included in this survey come largely from the service of Dr. Cameron Duncan.

The material to be reviewed includes all the advanced cases of carcinoma of the cervix referred to the radiation therapy department for treatment from 1931 to the beginning of 1936. In other words, in the most recent cases reported, over a year has elapsed since the end of treatment. The first cases treated have passed six years. While the time interval is much too short to permit a discussion of cures, yet it is ample to justify a review of the palliative value of radiation therapy in advanced cervical carcinoma. The character of material seen at Kings County Hospital is discouraging at the outset. Our clientele consists largely of the poorer charity patients—patients who neglect themselves too long, patients who lack the intelligence or ease needed for better co-operation. The hospital also serves as the recipient of free patients treated inadequately or unsuccessfully at other institutions throughout the city.

In classifying our material, we have followed the scheme of Schmitz, with one slight modification. We felt that we were justified in including in Group III those cases in which the cervix was extensively involved without definite palpable paramet-

trial infiltration, but in which the cervical canal is atresed by neoplasm. The atresia of the cervical canal prevents adequate application of radium. The prognosis in these cases is similar to that in Group III. Essentially, the clinical classification of carcinoma of the cervix can be reduced to two main groups: Schmitz Groups I and II in which the cervix alone is involved, and Schmitz Groups III and IV in which the pathology has spread beyond the cervix. One hundred forty-one cases of cervical carcinoma in Groups III and IV are included in this review. These cases represent 92 per cent of all the carcinoma of the cervix referred to the department. Thirty-two of our patients received treatment at other institutions prior to their admission here. Frequently the treatment received had been considerably less than that which we felt advisable. Forty-one patients were classified as in clinical Stage III, 100 patients were classified as in clinical Stage IV.

Microscopic examination classifies 83 per cent of the cases as epidermoid carcinoma, and 17 per cent as adenocarcinoma. Grading of the degree of malignancy was carried out in relatively few cases. Our pathologists feel that the grading of malignancy is still of doubtfully proven value. Our own clinical experience is in accord with this, for not infrequently have we found lesions that were reported as highly sensitive to radiation which did not respond to massive dosage of radiation. Furthermore, some tumors considered radiation-resistant disappeared grossly even before the course of preliminary x-radiation was complete. In a few instances successive biopsies of the same tumor were reported at one time as radiation-resistant

<sup>1</sup> Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

and at another time as radiation-sensitive. Our own experience leaves us unimpressed as to the importance of the grading of malignancy as a factor in determining dosages to be given. All patients were treated with the maximum dosage considered safe to be administered.

*Symptoms.*—Bleeding was the predominant symptom and the chief complaint in 123 cases. The duration of bleeding even in the advanced cases varied between a few weeks and almost two years. When the bleeding was of short duration, there was always a history of a previous foul, watery discharge, and examination showed instead of an exophytic friable mass, a sloughing, indurated, secondarily infected, neoplastic crater.

Twenty-one patients arrived in good condition, 71 in poor condition, and 39 were definitely cachectic. Those not in good condition complained of weakness, shortness of breath, and the other major symptoms of secondary anemia.

Forty-two patients complained of pain in the pelvis and lower back. Thirty-eight patients complained of a watery discharge. Fourteen complained of frequency of urination or dysuria. Two patients complained of inguinal lymph-gland swellings. Five patients had either rectal or vesical fistula.

*Treatment.*—The maximum dosage as yet delivered to extensive pelvic carcinoma is too frequently below that needed for complete carcinoma cell death. With the popularization of the protracted, fractionated method of administering x-ray therapy as advocated by Coutard and others, radiation therapists throughout the world have rapidly altered their conception of tissue tolerance and available dosage. If we are to increase our therapeutic results, we must bring the total parametrial dose near to what we believe to be the carcinoma lethal dose. Perhaps further application of the principles involved in the time-spacing of treatments, will permit increased total dosage and increased carcinolytic effect. Our treatment technic has been as follows: 200 kv. Thoraeus filter of 2 mm. Cu equivalent,

50 cm. F.S.D., 100 r in air measured to each of four pelvic fields daily until 3,000 r has been given to each field. Fields measured approximately  $10 \times 15$  cm. and the rays were directed so as to converge into the pelvic floor. In no instance was cystitis or proctitis produced although the bladder and rectum were not protected.

Immediately on completion of x-ray treatment, each patient was re-admitted to the hospital for radium insertion. A Gaillard sound containing three 15-mgm. capsules of radium element was placed within the canal and three corks of a colpostat, each containing 10 mgm. of radium were placed within the vagina, one cork resting in each lateral fornix and one cork anterior to the cervix. The rectum and bladder were packed away with a few folds of gauze vaginal packing. The rest of the vagina was filled with plain gauze packing to prevent undue change in position of the radium applicators. Thus, 75 mgm. of radium were used and permitted to remain in place for 96 hours, yielding a total dosage of 7,200 mgm.-hours. In those cases in which the cervical canal was atresed, no effort was made to dilate the canal and only the intravaginal applicators were used. If the carcinoma was bulky, exophytic, it usually shrank to practically normal within from four to six weeks. By then the canal usually was found to have become patent again. The intra-uterine radium application was given as soon as patency was established. In one instance a bulky cauliflower-like tumor was removed using a coagulation loop. Electrocoagulation is not advised—it is associated with danger—the coagulation may extend well into the vaginal vault and lead to subsequent hemorrhage or pyometritis. Furthermore, it is superfluous inasmuch as the exophytic carcinomas that might be snared off respond very readily to radiation. The radium dosage was usually given as one treatment without repacking the vagina, hence making a reinsertion of the radium unnecessary. If the patient's temperature rose above  $101^{\circ}$  F.

on the second or third day, the radium was removed, the vagina douched, and the radium reinserted a few days later. In only a small percentage of the cases was there sufficient morbidity to warrant interruption of the four-day continuous application. It is wise to plan the total radiation as one continuous course and not to attempt second, additional cycles or series of treatments. The first cycle or series of treatment is the most effective and should be as intensive as possible. Subsequent therapy is associated with additional danger and produces very little, if any, therapeutic benefit. In one instance a secondary cycle of radiation given almost two years after the first series, led to a late radiation necrosis of the lower pole of the cecum, with perforation and fatal peritonitis. The radium dosage of 7,200 mgm.-hours, correctly applied, never produced any severe local symptoms, proctitis, or cystitis. When the dose was carried to 8,000 or more mgm.-hours, a three- or four-week proctitis was a usual complication. In no instance was a rectal or bladder radium fistula encountered. One case, on autopsy, several weeks after radium insertion, showed a perforation of fundus uteri with a conical zone of necrosis. This case had been curetted seven days before. The zone of necrosis was not far from the tip of the radium applicator; in other words, in the region of the uterus receiving the smallest total radium dosage. The perforation, therefore, represented a surgical rather than a radiation complication. In five cases a laparotomy was performed and an attempt was made at carrying out a pelvic lymphadenectomy similar to that recommended by Taussig. Radon seeds were inserted into the residual gross neoplastic tissue. The post-operative courses in these cases was always hectic; repeated transfusions were required, and in one patient a rectal fistula was produced. Two of these five patients subsequently died with extensive pelvic infiltration, urethral obstruction, and progressive cachexia. In one case, re-opened a year after the seed implantation, no gross pathology could be

found. This is the only really successful seed implantation case in our group. The procedure here was limited to seed implantation—no lymph gland resection was done. The series of five cases is too small to warrant definite conclusions, but the suggestion is made that lymphadenectomy or seed implantation is applicable only in the earlier cases, that is, in those cases in which the therapeutic results are favorable even without this procedure.

*Relief of Symptoms*—Bleeding was controlled in 66 per cent of the cases treated. Many of the patients who were bed-ridden and exsanguinated on admission, improved so markedly after treatment that they returned to their homes able to do their housework and to care for their families. Frequently, this improvement was temporary but nonetheless definite and welcome. The general condition of the patient was definitely improved in 43 per cent of the cases treated. The hardest cases to help were those in whom the lesion at the time of first examination was sloughing, foul smelling, ulcerated, flush with the vaginal vault. The bulkier lesions, those without extensive secondary infection or necrosis, responded very satisfactorily. The local lesions healed completely in 36 per cent of the cases treated. The palpable pelvic infiltration healed in 14 per cent of the cases treated; however, the lumbar pain did not always disappear with the disappearance of the palpable mass. Pain was relieved in only 5 per cent of the cases treated. The watery discharge was relieved in only 3 per cent of the cases treated. Twenty-seven of the 141 cases seen are still alive and 12 of these are, grossly, cancer-free. Of all the Group III and IV cases seen, 11 per cent are known to have lived from one to six years or more after completion of their treatment. However, correcting these figures by eliminating those cases that arrived in such poor condition that they did not live through the weeks necessary to complete radiation therapy, or who were too cachectic to be treated, there is a survival rate of 32 per cent. Of all the cases seen, 76 lived less than six months, 20

survived from six to 12 months, 18 survived from 12 to 18 months, nine survived from 18 to 24 months, 10 survived from 24 to 36 months, four survived from 36 to 42 months, two survived from 48 to 54 months, and two survived more than five years.

The immediate cause of death was difficult to establish. The claims for urethral obstruction as a major cause of death could not be substantiated in our own group of cases. In only five of the cases studied could definite urethral block be demonstrated. Secondary hemorrhage and the sequelæ of long-standing pelvic infection with its progressive cachexia dominate the clinical picture.

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#### CONCLUSION

Radiation therapy adequately administered offers definite palliation in a large percentage, and a cure in a small but constant percentage, of those suffering from advanced carcinoma of the cervix. This treatment should be resorted to in all but the extremely cachectic cases. Further improvement in therapeutic results from radiation probably depends on our ability to increase still more the total radiation dose and to understand better the problem of time and space distribution of the dosage.

# THE BIOPHYSICAL BASIS OF ULTRA-SHORT WAVE THERAPY<sup>1</sup>

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## 1. INTRODUCTION

**A**T the present time three problems are of especial importance in regard to the medical applications of ultra-short waves: (1) dosage measurement; (2) the relation of selective heating effect to wave length; (3) the specific effects of ultra-short waves (athermic, or specific electric effect). This last problem lies mainly in the field of medical biological investigation, while the first two are entirely within the field of biophysical research, and are accordingly the subject of our present considerations.

Modern ultra-short wave apparatus is serviceable and reliable and enables us to make more or less exactly reproducible applications of ultra-high frequency energy. There is, however, no reliable dosage procedure which permits, in any given case, the correct determination of the energy transferred. Especially is it difficult to measure the dosage during the actual treatment. The present practice in ultra-short wave therapy is to rely on the subjective reaction of the patient. The resulting dose can, in general, only be determined in an empirical manner.

As a result of the difficulties of exact dosage determination, it has not as yet been possible to make any definite observations or to reach any conclusion regarding so-called "specific effect" of ultra-short waves, and in the present state of affairs it will continue to be impossible to do so.

The idea of constructing the treatment system, on the basis of physical and physiological-anatomical considerations, in such a manner that conditions can be so predetermined that a favorable transfer of energy may be expected, leads directly to the second of the above-mentioned problems;

*the wave length dependence of the effects of ultra-short waves.* That is, is it possible, by an appropriate selection of the wave length region, to influence the transformations of the high frequency energy in various body tissues in the desired direction? Within recent years considerable research has been done on this problem, which is of the greatest importance, both for the practical application of ultra-short waves and for any investigation into the mechanism of their biological effects. As a result of this research, there is to-day available some definite knowledge regarding the distribution of the high frequency energy, and also the mechanism of its conversion in the irradiated body. On this basis the problem is divided into two parts: on the one hand the investigation of the "external" or geometrical conditions for the supply of the high frequency energy, and on the other, the determination of the actual distribution of the high frequency energy within the body. The first part of the problem is directly concerned with such matters as size, shape, material, and arrangement of the electrodes. The second has for its purpose the determination of the electrical characteristics of biological bodies; that is, their high frequency conductivity and dielectric constant (DK), as well as the clarification of the bearing which the stratified, fibrous, or cellular structure of the individual tissues has on these constants. While the questions regarding the "external" conditions are relatively well cleared up, and have found sufficient place in the literature, those regarding the inner mechanism of the passage of the ultra-short wave current have up to now been little considered.

## 2. THE PRINCIPLE OF SELECTIVE HEATING

Animal tissue is, from an electro-physical point of view, a complex, poorly con-

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ducting body, whose outstanding characteristic is its macroscopic stratified structure, and its microscopic and submicro-

If a high frequency voltage is impressed across its terminals, the resulting current consists of two parts: a conduction cur-

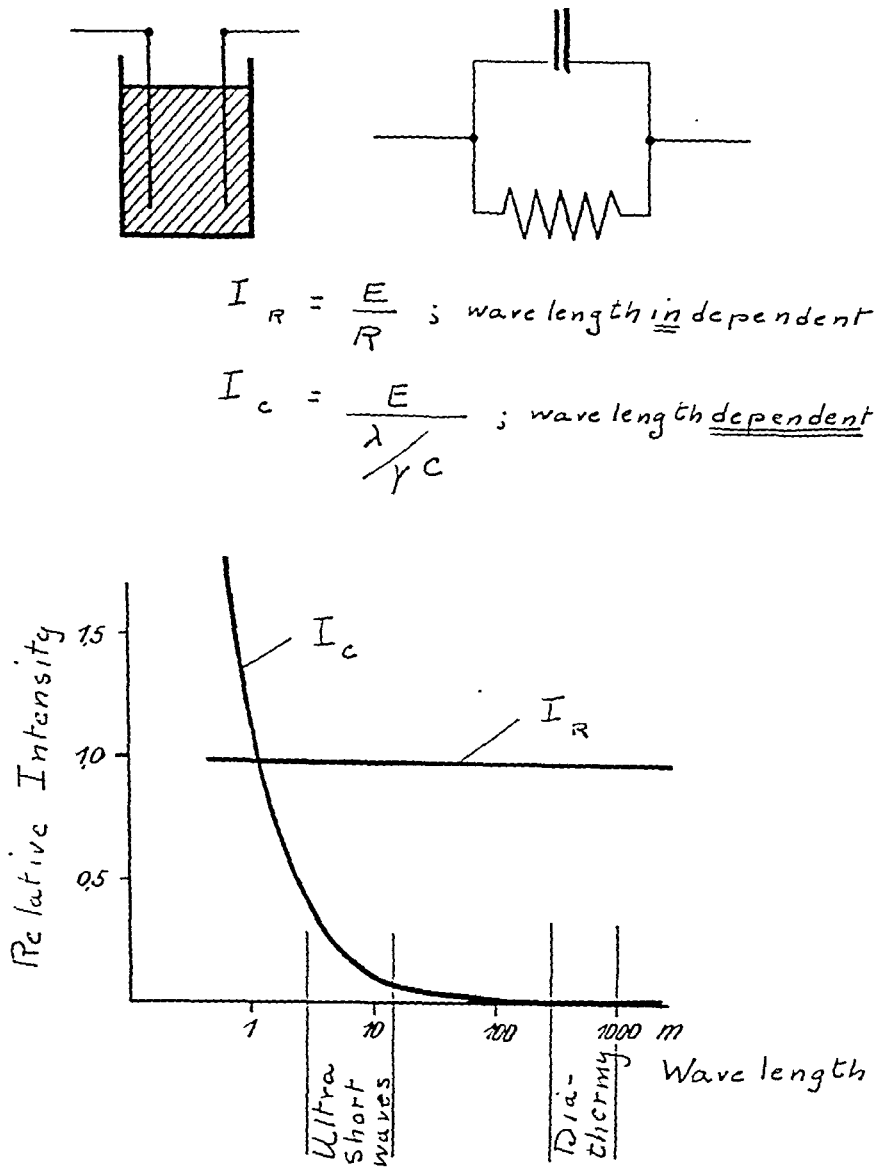


Fig. 1. Simple equivalent electric circuit for the conductivity of a biological body in a high frequency condenser field.

scopic fiber-, cell- or colloid-structure. The different components of tissue possess, in general, different values of conductivity and dielectric constant. The body can, therefore, be considered as an inhomogeneous dielectric. The passage of a high frequency current through such a body can be symbolized by the type of electric circuit shown in Figure 1. It consists of a resistance R and a condenser C in parallel.

rent  $I_R$  through the resistance R, which produces heat, and a so-called capacity displacement current  $I_C$ , which flows without energy loss.  $I_R = \frac{E}{R}$ , where E is the alternating voltage across the condenser, and  $I_C = \frac{E}{\frac{\lambda}{\gamma c}}$  where  $\lambda$  is the wave length,



$\gamma$  a constant, and  $C$  the capacity. It is important to note that the first, the conduction current, is independent of the wave length, while the second increases with decreasing wave length (See Fig. 1). The wave length region for ultra-short wave therapy is such that the conduction and displacement currents in the irradiated tissue are of the same order of magnitude.

The displacement current makes it possible to irradiate non-conductors without waste of energy. In ultra-short wave therapy, the metallic contact between the electrodes and the skin can be omitted and the electrodes set at a distance from the body. Such an arrangement is called a condenser field. First described by Esau, it has proved to be the most suitable method for ultra-short wave irradiation of biological objects.

It is of especial interest to investigate the laws governing the distribution of energy within an irradiated cross-section of tissue. Such a cross-section, in practice, consists of a series of several tissue layers, with different conductivities and different dielectric constants, and the question is how the energy distribution in these various layers varies with the wave length.

Schliephake (1) found, in the first investigation of this question, that for a series of salt solutions of various concentrations, there was a wave length dependence of the heating of the individual solutions. Paetzold (2) showed, in support of this, that this is an entirely normal consequence of the theory of alternating currents, since the relative intensities of the conduction and displacement currents are different, in the different layers, for different wave lengths, and therefore the resultant development of heat should have a wave length dependence. According to this, there should be, for every tissue having a certain conductivity and dielectric constant, a certain wave length which should give the maximum effect; this wave length can be determined by the formula given by Paetzold. Other workers have verified this, both in theory and practice (3, 4).

The thorough investigation of this "prin-

ciple of selective heating" requires involved mathematical considerations. We will here consider briefly only the basic results: first, the formulation of the principle itself. Its therapeutic application consists in the delivery to a certain layer of tissue, or to a certain organ, the largest possible amount of energy, with the greatest possible avoidance of neighboring layers or structures. Quantitatively the state of affairs is best expressed by the quotient  $Q = \frac{H \text{ desired}}{\Sigma H \text{ undesired}}$ ,

where " $H$  desired" is the energy delivered to the tissue under consideration, and " $\Sigma H$  undesired" is the sum of the energies delivered to all the other tissues. The selective warming of a tissue requires, obviously, that the quotient  $Q$ , which we may call the selectivity factor, shall be a maximum; the problem, therefore, is to find the wave length which produces this situation. In statements of the principle of selective heating heretofore published, it is indicated that for every tissue of a definitely determined conductivity and dielectric constant, there is an optimal treatment wave length which will make this factor a maximum. As will be shown below, the value of the quotient  $Q$  depends on the relation between the magnitudes of the conductivity and dielectric constant of the various tissue layers. For this reason, Paetzold's formula is subject to certain limitations. First, it is obviously not applicable to the treatment of a single layer. In this case, the heating effect increases regularly with increase in wave length, for a constant current. Also in the case of two layers there is no optimal wave length. For three or more layers, however, the matter deserves consideration. In Figure 2,  $A$ ,  $B$ , and  $C$  are given diagrams to aid in the consideration of this case; here we have various arrangements of three layers having the same dielectric constant but different conductivities. In the general problem, the layers would also have different dielectric constants, but in the interests of simplicity we will consider only the special case. This is not unreasonable, since actually, for various body tissues, the dielec-

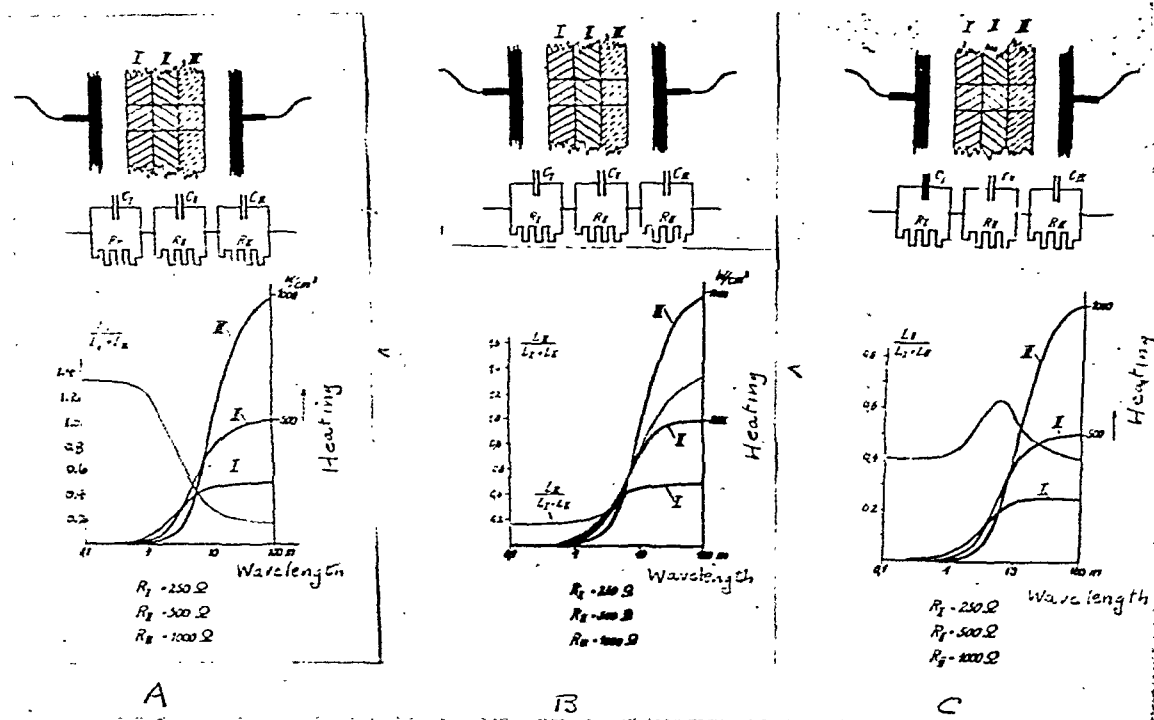


Fig. 2. High frequency heating of one layer of tissue out of three having different conductivities and the same dielectric constant.

- The layer to be heated has the greatest conductivity  $L_I$ .
- The layer to be heated has the least conductivity  $L_{III}$ .
- The layer to be heated has a conductivity between the other two  $L_{II}$ .

tric constants in the ultra-short wave region are about the same, with few exceptions. As my collaborator, H. Schaefer, has stated, with such stratifications, three cases must be considered:

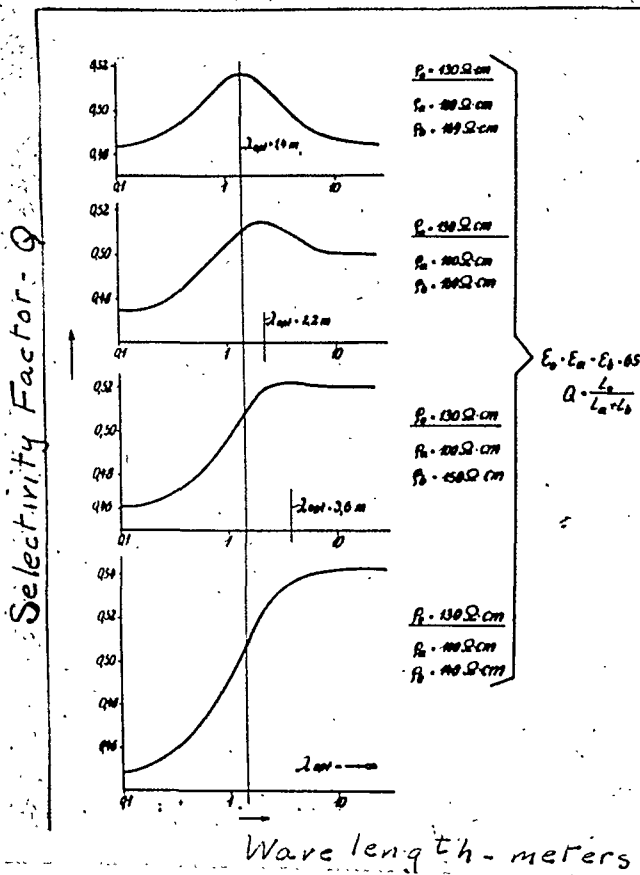
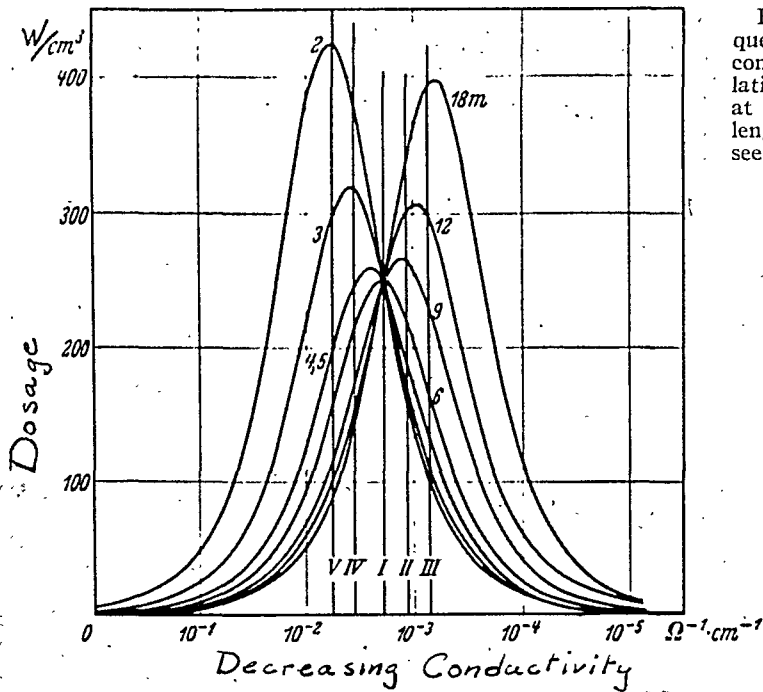
1. The conductivity of the layer to which it is desired to deliver the maximal dose is greatest of the three; or
2. it is the least; or
3. it is intermediate between the other two.

Of these three possibilities, the first leads to the conclusion that the shortest possible wave length produces the desired result. In this case, then, there is no meaning to the expression of an optimal wave length. Correspondingly the second case leads to the need for the longest possible wave length. Only in the third case is there an optimal effect for a determinable wave length, for which Paetzold's

formula holds, namely,  $\lambda = \frac{\epsilon \rho}{6 \times 10^3}$  where

$\rho$  is the specific resistance of the tissue,  $\epsilon$  its dielectric constant, and  $\lambda$  the wave length. These considerations are best shown by a graphic representation of Schaefer (3) reproduced in Figure 3-A. Here are given curves showing the relation between the heat produced by various wave lengths and the conductivity of the irradiated tissue, when the apparatus is operated so that for every wave length the same heat is developed for one particular conductivity (Point I). For this example, this conductivity is selected as that which will develop a maximum dose for radiation of 6-meter wave length. Case 1 above is now illustrated by a consideration of layers I, II, and III. Here, for the 6-m. wave length, the undesired total in II and III relative to I is about 150 per cent (selectivity factor 0.67).<sup>2</sup> On the other hand, the corresponding undesired dose for a 3-m.

<sup>2</sup> H desired = 250.  $\Sigma$  H undesired = 215 + 160 = 375  
 $\Omega = \frac{250}{375} = 150$ .



B. Shift of maximum in selectivity factor because of constants of adjacent tissue layers.

wave length is only 109 per cent (selectivity factor 0.92). Case 2 is illustrated by layers V, IV, and I. Here again the undesired total for 6-m. radiation is 150 per cent of the dose at I, while in this case the longer wave length of 12 m. gives a smaller total of 109 per cent. Case 3, for layers IV, I, and II, is the only one to which Paetzold's formula applies. It is apparent, then, that the application of the principle of selective heating is possible only in certain special cases. This must be emphasized because, even in the third case just mentioned, considerable deviations may occur between the actual optimum wave length and that calculated from the formula, because of the constants of the neighboring layers of tissue. These considerations are best illustrated by Figure 3-B, in which is shown the displacement of the optimal wave length produced by changing the conductivity of one of the outside layers, keeping that of the other two layers constant.

The quantitative determination of the above relations is possible only if the numerical values for the conductivity and dielectric constant of the biological tissues in the short wave length region are known. Hence speculations as to the possibility of relative heating of various body tissues are of no value, as we pointed out more than five years ago. In order to clarify this matter, and also for other fundamental reasons, we have undertaken a systematic measurement of the conductivity and dielectric constant of all therapeutically important tissues in the ultra-short wave region, from wave lengths of 0.5 to 1,500 meters. These measurements, which we have already published (5, 6, 7, 8, 9, 10, 11), have led to a series of results which are of basic importance, not only with regard to the matters considered above, but also to general considerations concerning the mechanism of the distribution of high frequency energy in irradiated biological tissues. Meantime results along these same lines have been published by Fricke and Curtis (12), Esau, Paetzold, and Ahrens (13), Bachem (14), and Osswald (15),

which are in good agreement with our own and with the theoretical developments we have made from these results. In Table I are given the individual values for conductivity and dielectric constant for various

TABLE I.—CONDUCTIVITY AND DIELECTRIC CONSTANT OF HUMAN TISSUES FOR THREE-METER WAVE LENGTH (37°)

Tissue	Conductivity × 10 <sup>3</sup>	Dielectric Constant
Muscle	8.5-10.4	65-75
Kidney	8.5-10.0	
Brain	4.5- 6.25	
Spleen	9.6-11.6	
Lung	7.7-11.5	
Heart muscle	7.8- 9.2	
Liver	6.3- 8.7	
Gastric mucous membrane	10.0	
Subcutaneous fat	0.83	9-13
Skin	2.1- 6.25	

TABLE II.—CONDUCTIVITY AND DIELECTRIC CONSTANT OF ANIMAL TISSUES FOR THREE-METER WAVE LENGTH (37°)

Tissue	Conductivity × 10 <sup>3</sup>	Dielectric Constant
Muscle	6.8 - 8.5	71 - 76
Liver	5.6 - 6.5	76 - 79
Spleen	8.3 - 8.4	100 -101
Kidney	6.9 -11	87 - 92
Brain	5.1 - 5.6	81 - 83
Pancreas	4.1 - 5.9	60 - 75
Fat	0.4 - 0.58	11 - 13
Bone marrow	0.20- 0.35	6.8 - 7.7
Blood	10 -12.5	73 - 76
Serum	16	76

human tissues, for a wave length of 3 meters; Table II presents corresponding values for animal tissues. If these values are used for the determination of the relative quantitative effects in selective deep heating, it is found that, in general, the selective effect, as related to the wave length, is very small, even for very different values of the conductivity of the various layers. An actual example for body tissues is given in Figure 4-A (*after* Schaefer), showing the attempt to produce specific heating in the liver, as related to skin and gastric mucous membrane. Obviously there is no advantage, in such a case, in attempting to treat with an "optimum"

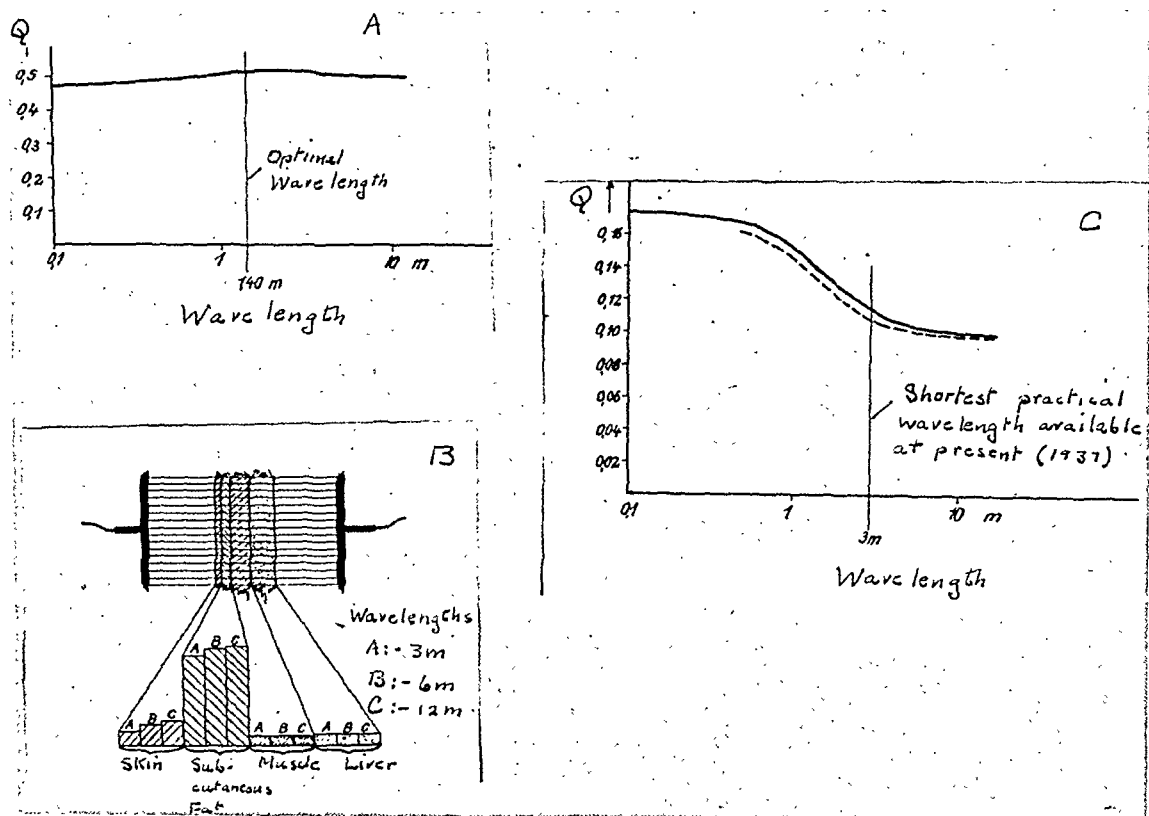


Fig. 4. Wave length effects in animal tissues.

A. Skin-liver-gastric mucous membrane.  $Q$  = relation of desired dose (in liver) to undesired (in other tissues).

B and C. Variations in dose in combination skin-subcutaneous fat-liver with variations in wave length. Extreme electrode spacing, giving homogeneous field. Dose in liver maintained constant.

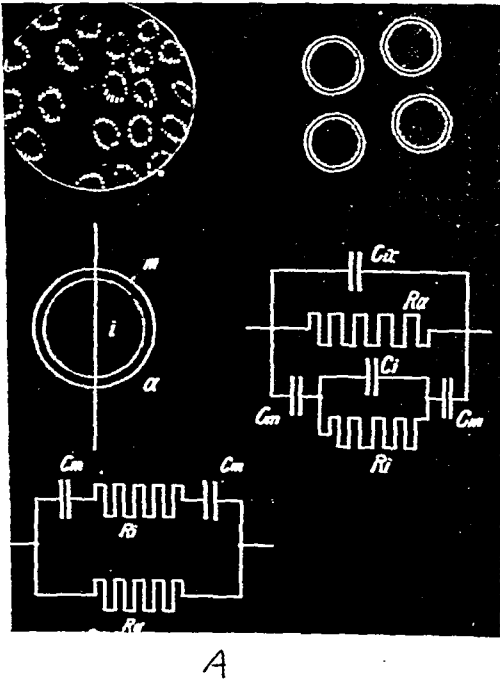
wave length rather than with any other. Only in one particular case is this really possible, namely, in the heating of subcutaneous fat. This tissue has a conductivity and dielectric constant completely outside the range of those for other tissues. And here there is actually a definite example of the often mentioned wave length variation in the relation between the useful and the undesired heat. The quantitative relations are shown in Figure 4-B and C. They lead, actually, to the indication of the shortest possible wave length as the desired one. It should be noted that any selective heating effect for fat is found only for wave lengths below 3 m. The values for the temperature effects in fat as calculated from the measured values for conductivity and dielectric constant, which are given in the figure, are in good agreement with the direct temperature meas-

urements of Esau, Paetzold, and Ahrens (13), and of Bachem (14).

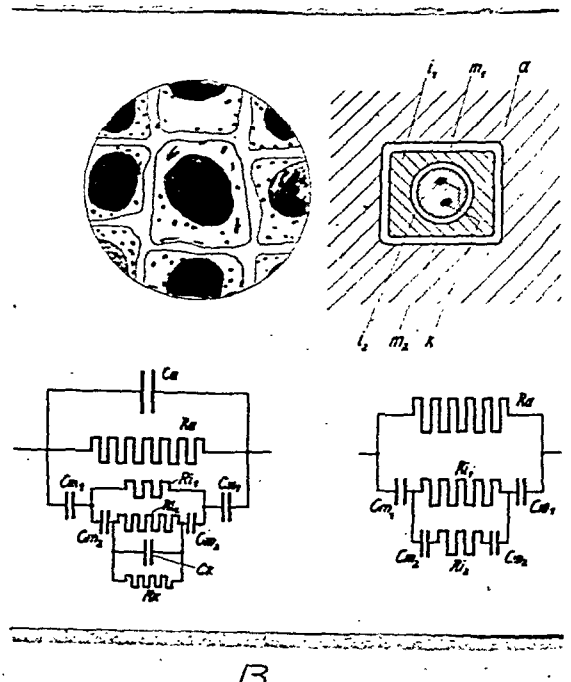
### 3. THE MICRODISTRIBUTION OF THE HIGH FREQUENCY ENERGY IN THE TISSUES

Even though it can be shown that, except for special cases, the hope for a selective distribution of high frequency energy among various organs cannot be realized, still the stratified structure of biological tissues is important, for another reason. The microscopic layer structure of the cell groups and of the single cells exerts a strong influence on the distribution of the energy in the irradiated tissue.

Researches which have been carried on in our laboratory for many years, on the behavior of biological objects in the high frequency condenser field, have led us to the announcement and the theoretical establishment (Daenzer, 7b) of a series of



A



B

Fig. 5. Diagrams of structures and equivalent electric circuits.  
A. Blood.  
B. Cellular tissues.

concepts whose further pursuit has proved very fruitful (16, 17). For the essential confirmation of this theory, it is necessary to know the wave length dependence of the conductivity and dielectric constant of the individual tissues. This problem may be readily illustrated by concrete examples—as a relatively simple one, the blood, and as a complicated one, the cellular tissues. In the first case we have to deal with a suspension; the blood corpuscles can be considered as hollow spheres suspended in a conducting fluid. Each corpuscle is composed of a semi-insulating shell (membrane) and a conducting fluid within this shell. It makes no difference in the following considerations, whether the corpuscle is considered as a sphere covered with a membrane, or as a particle having a honeycomb-like inner structure. Correspondingly, we can consider a cell group as a complicated manifold layer, which consists of poorly conducting membranes and framework, and, enclosed in these frames, the better conducting cell fluids. If one analyzes the behavior of such a system in a high frequency

field, he comes to the situation which is illustrated in Figures 5-A and 5-B. The actual biological tissues and cells can be replaced diagrammatically by the equivalent electrical circuits shown. It is important, in these circuits, that all condensers should be independent of wave length. Then according to the wave length used, the system will show varying total conductivity, since the current flowing in the individual conducting parts of the cell will vary according to the wave length. These theoretical considerations have been fully established experimentally; the conductivities and dielectric constants of tissues are found to be strongly wave length dependent. Examples of this are shown in Figure 6-A, where the specific resistance, or the reciprocal of the conductivity, is the ordinate of the curve. It is evident from these curves that the variations with wave length are not of the order of a few per cent, but are much greater. For example, measurements on blood have shown that in the ultra-short wave region, as opposed to longer waves (diathermy), for the individ-

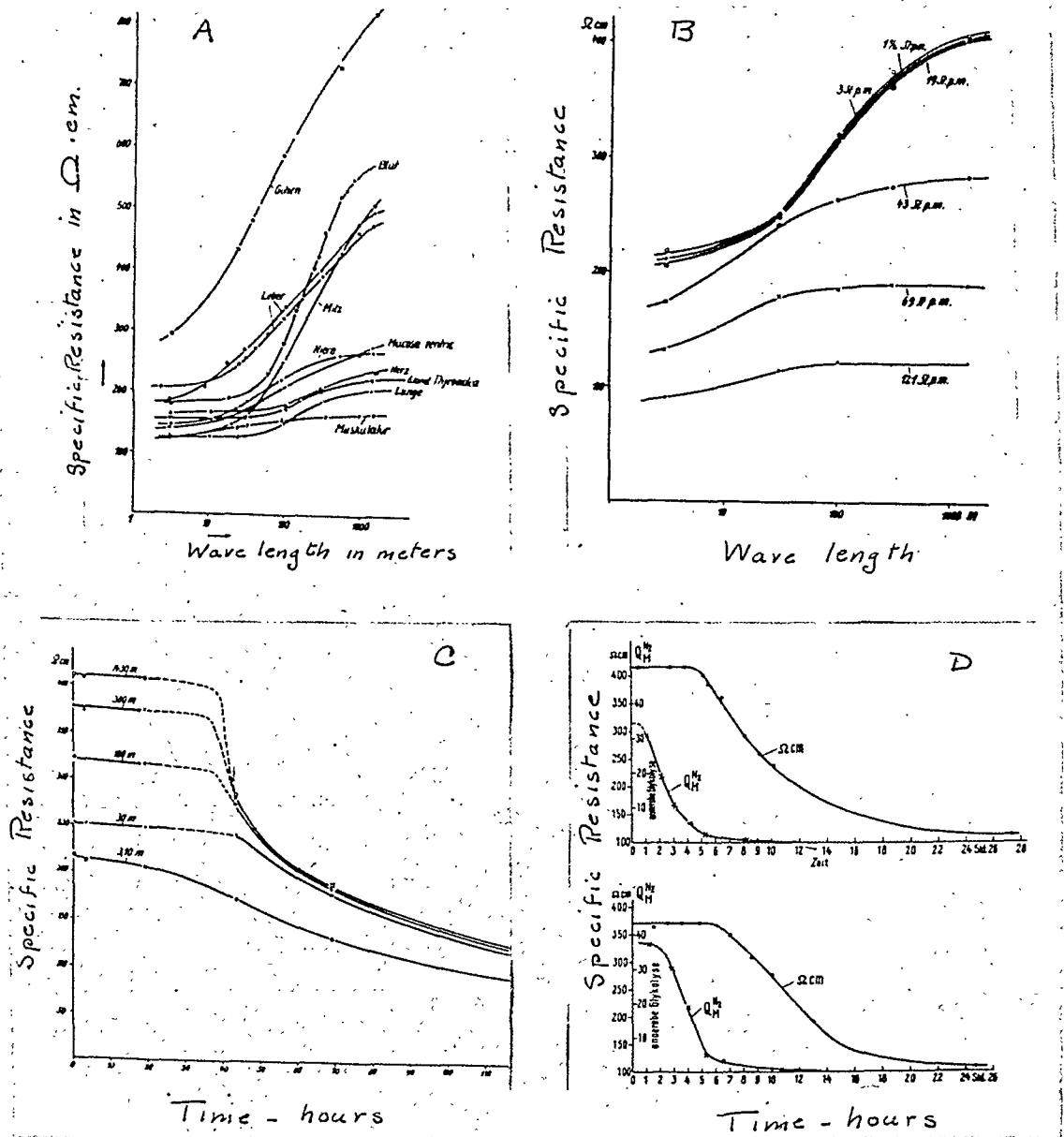


Fig. 6. A. Dispersion curves for high frequency conductivity in various tissues.  
B and C. Variation with hours after death in the high frequency conductivity curves for rabbit liver.  
D. Variation with time in glycolysis and in growth ability in sarcoma tissue subjected to autolysis.

ual blood corpuscles there is a 20-fold increase in energy absorption. Thus there is a complete change in the whole picture of energy transfer.

In addition to the consequences which these facts have on the practical application of ultra-short wave therapy, there is further important information to be gained from measurements of conductivity and dielectric constant. If the cell structure

has any influence on the wave length dependence of the conductivity (the so-called dispersion curve), then changes in the cell structure must express themselves in changes in the shape of this curve. The experiments verify this completely. First let us consider individual differences in dispersion curves for tissues of the same sort, such as are shown in Figure 6-B, for liver. Even more definite are the changes in high

frequency conductivity with destruction of the cell structure, such as take place, for instance, in hemolysis of blood corpuscles, or in postmortem changes due to autolysis or bacterial action. In the intact cell, the membrane shuts in the cell fluids so that they do not participate in the general conductivity. When it is destroyed, however, these fluids become a factor in the conductivity, even at relatively low frequencies, *i.e.*, long wave lengths. The dispersion curve for the high frequency resistance must be lowered as the result of such processes, and in the limit must go over to a straight line (electrolytic conduction). That this is actually the case is shown in the experimental examples of Figures 6-B and 6-C. In addition to these cellular destructive processes, other changes in the life history of the cell can be investigated by this type of dispersion analysis. For instance, it is possible to correlate the life activity of tissue cultures with the measured dispersion curves. In Figure 6-D is given an example of this, for a sarcoma tissue. The abscissæ show the time elapsed since the excision of the tissue fragment, the ordinates, the specific high frequency resistance and the glycolysis ( $Q_M^{N_2}$ ), or the frequency of takes of tissue cultures made from the same tissues.

### CONCLUSIONS

From the results of experiments herein described, the following conclusions can be drawn:

1. Under the conditions of present-day ultra-short wave therapy, there is in general no possibility of a practical application of the so-called principle of selective heating. Recent investigations along these lines indicate, in the main, the advisability of using the shortest possible wave length. Especially favorable relations appear to exist in the region of about three meters, which is, however, practically not very ac-

cessible at present. Further technical development is to be hoped for in this region.

2. The characteristic peculiarities of the behavior of biological tissues in the ultra-short wave region lie in the elementary (microscopic) division of the high frequency energy in the biological system (cell groups, blood, colloidal suspensions, etc.). The significance of this microscopic tissue structure is expressed by the marked wave length dependence of the high frequency conductivity and dielectric constant of the tissue, which always conforms, as experimentally demonstrated, with the individual physical and anatomical characteristics.

3. It does not appear improbable that the ultra-short wave current, in addition to its already extensive therapeutic applications, should also serve as a useful diagnostic adjunct in the recognition of pathological changes in cell structure.

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## NEWER STUDIES ON THE CLINICAL APPLICATION OF VERY SHORT ELECTRICAL WAVES<sup>1</sup>

By DR. JOHANNES PAETZOLD, *Erlangen, Germany*

TREATMENT with short wave diathermy in a condensor field, using frequencies from  $2 \times 10^7$  to  $10^9$  Hz (or wave lengths from 15 to 3 meters) is definitely superior to long wave diathermy ( $3 \times 10^5$  to  $10^6$  Hz or 1,000 to 300 meters wave length) as regards deep doses and the

short wave energy which can be applied is limited because of the increase in the temperature of the subcutaneous fatty tissue. I call attention to the difficulties encountered when trying to produce high temperatures within the pelvis when treating local gynecological conditions. Some of the

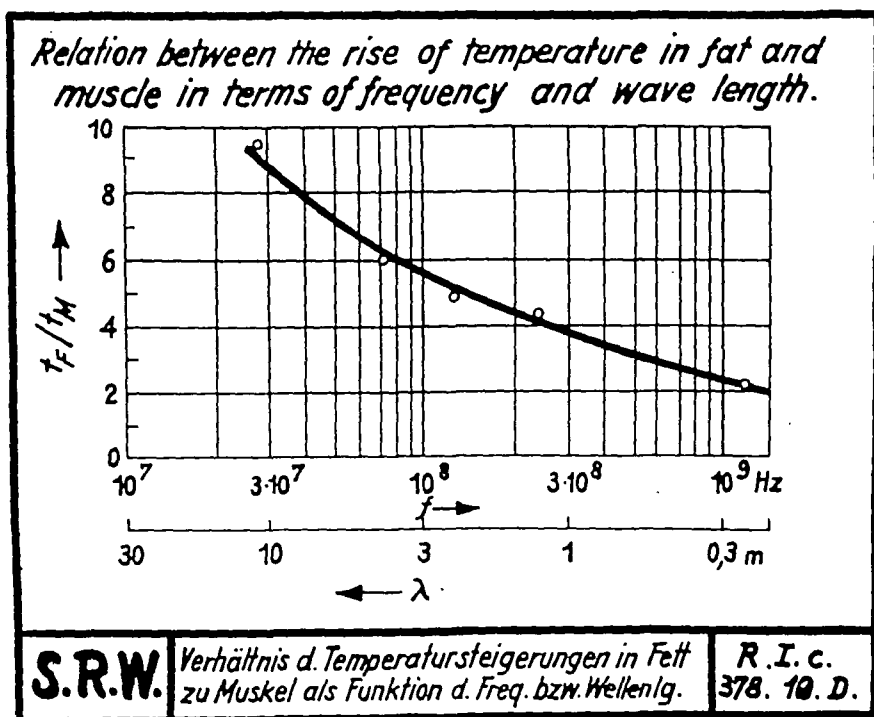


Fig. 1.

possibility of controlling the energy. From a physical point of view this superiority is due to greater thermal penetration of poorly conducting macroscopic and microscopic layers of tissue because of an increase in the capacitative conductivity and of the ohmic conductivity of the tissues. But even at wave lengths of 6 meters, there is such a strong thermal stress on the fatty tissues that the dose of

principal difficulties encountered in deep therapy are: (1) The circulation of blood in muscles and deep organs is greater than in the subcutaneous fatty tissues, and the blood stream disperses the heat more rapidly from these organs; (2) skin and subcutaneous fatty tissues are closest to the electrode and, therefore, lie in stronger fields than do the deeper lying tissues of the body, and (3) the caloric water value for fat is lower than for muscle and deeper seated organs because of its lower specific

<sup>1</sup> Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

weight and specific heat; in addition, the heat conductivity of fat is less than that of muscle.

large blood vessels. If, however, deeply seated organs of the body are to be heated, the conditions do not favor eddy currents,



Fig. 2.

These considerations raise the following important question: How can the severe thermal stress upon the fatty tissues be reduced, or, in other words, how can the deep dose be increased for local treatments? Obviously, the three factors mentioned above cannot be altered.

Another method of applying short-wave energy to a part of the body would be to place it in the electrical field of a coil; however, this method again does not give greater deep effects within the tissues. Numerous studies on layers of electrolytes within the range of body conductivities ( $10^{-4}$  to  $10^{-2} \Omega^{-1} \text{ cm}^{-1}$ ), as well as on biological material, have shown that the temperatures produced by these eddy currents in certain layers having high internal conductivities and low surface conductivities are better than those secured by the condensor field method insofar as the thermal stress upon the fatty tissues is concerned. However, the conditions which hold for this arrangement of tissue layers in the human body are present only in the extremities and in the trunk and then only if the treatment is limited to the heating of the connective tissues which contain

since these organs in themselves have only conductivities of the same order as muscle tissue through which blood flows. According to the studies on conductivity of high frequency waves made by Schaefer and Osswald, most tissues have even less conductivity than muscle. A careful study for the range of conductivity of the human body shows that the greatest conductivities occur at least twice within the layer, and for the eddy currents, this results in an absorption of practically all the energies by the outer layers which have the highest conductivity.

Shorter waves for eddy currents are not important because the distribution of heat within the layers does not change with wave length for eddy currents. On the contrary, the increase of the feeding frequency of short waves compared with the frequencies used formerly is injurious and causes the autofrequency of the coil to be small compared with the feeding frequency; therefore, the effects of this coil are no longer purely inductive. If feeding frequencies are employed which are large compared to the frequency of the coil used for treatment by the coil field method, the

coil reacts like a capacity and the laws of heating of materials in a condensor field also hold for the heating of tissue within

Institute of the University of Jena. For the first time we had at our disposal wave lengths down to 25 cm., using 30 watts.

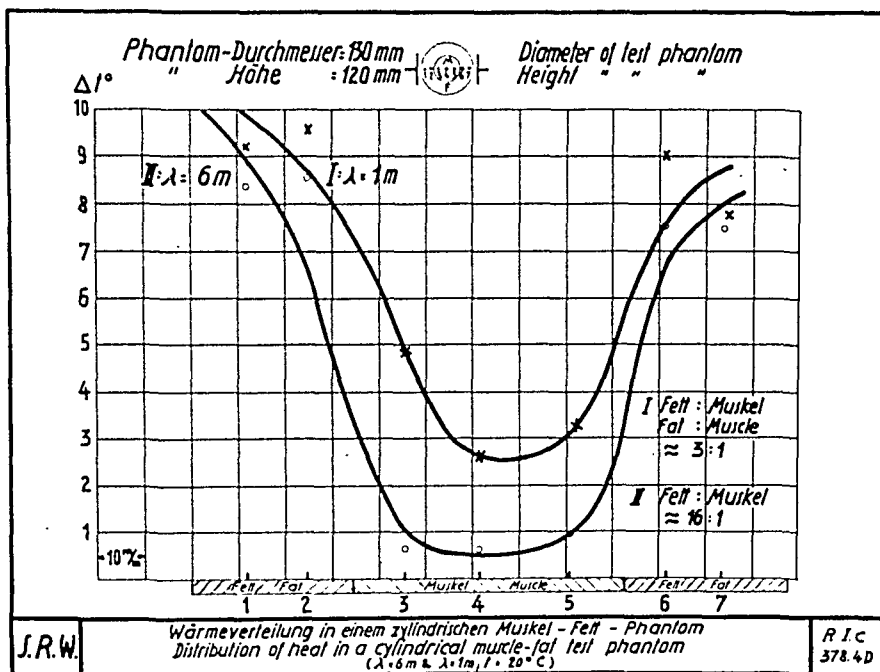


Fig. 3.

this coil. These relationships in regard to the heating of tissues with eddy currents can be mentioned only briefly, but it may be concluded that the principle of the coil never can produce higher depth doses in the body effectively.

In seeking methods to increase the depth dose, it seems advisable to carefully study the relative heating within the condensor field. It is well known that under certain conditions the relative heating of different layers can be changed on the basis of the theory of heating of layer dielectrics. If this is true then it is necessary to investigate the relationship of frequency to the heating of fat and muscle tissues because the frequency is the only factor which can be changed at will.

The measurements made on fat-muscle layers which have been published do not explain this problem satisfactorily; therefore, we began an investigation in 1936, in collaboration with Esau and Ahrens, in the Laboratory of the Technical Physical

We made preliminary experiments with waves from  $2.73 \times 10^7$  to  $1.2 \times 10^9$  Hz or from 11 meters to 25 cm. wave lengths. Since we had only 30 watts available for the shortest wave length, we used pieces of muscle and fat of about 3 c.c. which were placed in two chambers in series within a vessel made of trolitul. The results of these measurements made with an initial temperature of  $18^\circ C$ . are shown in Figure 1. The ordinate gives the ratio of temperature increase in fat to temperature increase in muscle; the abscissæ represent the frequency or wave length and the circles indicate the mean of four measurements, the variations among which amounted to about 20 per cent. The measurements show that there is considerable decrease of the heating of fats with increasing frequency. For example, the value for the heating of fatty tissue decreased from 9 to 3.8 down to 2 if the wave length was changed from 11 meters to 1 meter and to 25 cm.

Later, I made numerous experiments on muscle-fat phantoms, which approximated the true body volumes in collaboration with regard to the size of phantom, arrangements of electrodes, position of glass-benzol thermometer, etc. Figure 3 shows

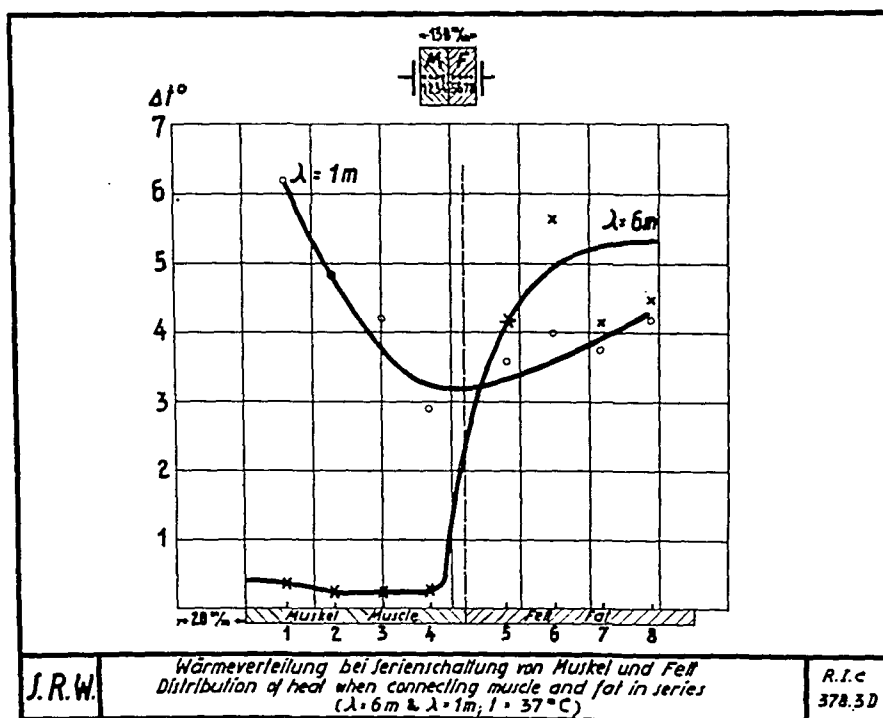


Fig. 4.

with Osswald, in the Laboratory of the Siemens-Reiniger Company. For this work, wave lengths of 6 meters and 1 meter, using various initial temperatures were employed. Lack of space does not permit a detailed description of the experimental set-up which is shown in Figure 2. The muscle-fat tissues were placed in a double-walled vessel made of trolitul and kept at body temperature throughout the experiment by blowing a warm current of air over the tissue; the muscle-fat phantom itself was placed in the thin-walled vessel of trolitul to prevent loss of tissue fluids.

In order to produce temperature increases of about  $5^\circ$  within a minute in the layer which was heated highest, we used a power of 200 watts while at a wave length of 1 meter, an initial power of 800 watts was available. The results of these measurements are shown in the next illustrations which also show important data in

the results of heating experiments on a cylindrical muscle-fat phantom. While the mean heating ratio of fat to muscle was of the order 16 to 1 at a wave length of 6 meters, it was found to be only 3 to 1 at a wave length of 1 meter. Figure 4 shows the results obtained for an initial temperature of  $37^\circ$  and for fat and muscle connected in series. All these measurements were made within an hour and a half after the animal (cow) had been killed.

In interpreting the results of these experiments, one must remember that actually the muscle layer always lies behind the fatty layer (as viewed from electrode) and that, therefore, the skin and subcutaneous fat usually lie within areas of greater field strength than muscle. This may explain the higher heating of muscle as compared with fat. Figure 5 shows the corresponding experiment with muscle and fat connected in parallel and measured at right-angles to the direction of the field.

These results are essentially the same as those demonstrated by our preliminary experiments. We should not expect too electric constants on biological substances for wave lengths from 3 to 12 meters have furnished a quantitative basis which per-

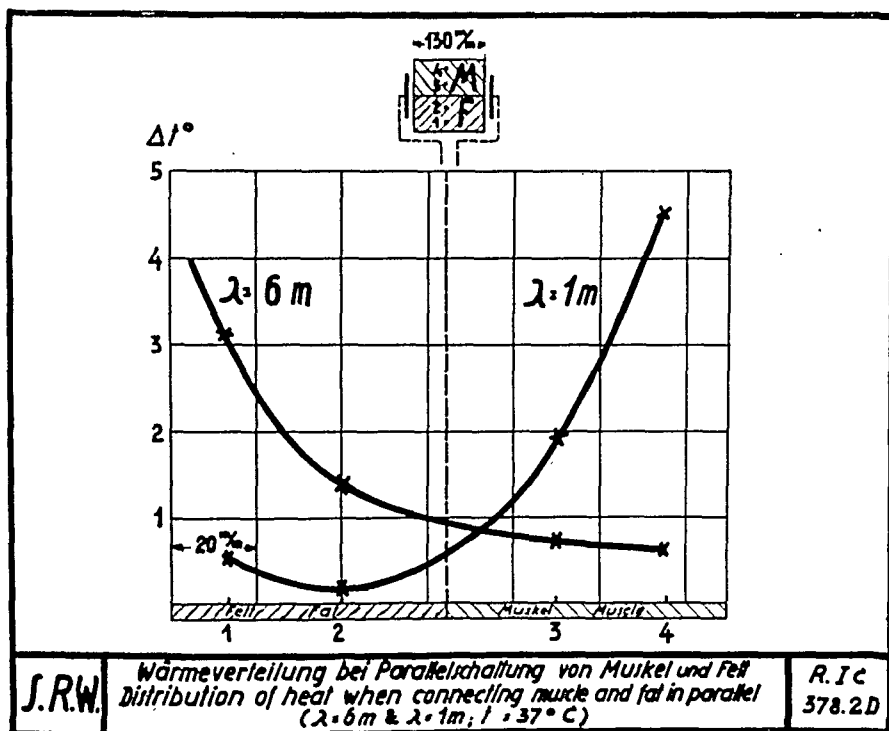


Fig. 5.

close numerical agreement of the values in the heating ratio in the different experiments since the readings are influenced by a number of factors which are difficult to control (arrangements of electrodes, placing of the thermometer, inhomogeneous fields, type of layer arrangement, irregular mixture of tissue, etc.). The parallelism of the heating ratio with that of the frequency and the temperature is of primary importance.

Of course, these phantom experiments are only a rough approximation of the actual conditions *in vivo*. Dead tissues lack the cooling effect of the circulating blood which naturally cannot be imitated in a physical experiment. However, these measurements do throw light upon the relationship of the heating of tissue at wave lengths of 6 meters and 1 meter.

Schaefer's measurements of conductivity in the ultra-short-wave field and Osswald's determinations of conductivity and di-

mits certain conclusions about the dependence of the heating of fat-muscle tissues upon the frequency which is employed.

The basis of the wave length dependence of the heating upon layers of different conductivities and dielectrical constants will not be discussed in detail; however, in this connection I should like to refer to my earlier papers in the *Zeitschrift für Hochfrequenztechnik*, 1930, and the *Zeitschrift für technische Physik*, 1932; to those of McLennan and C. C. Burton in the *Canadian Journal of Research*, 1931, and to that of Schaefer in the *Zeitschrift für experimentelle Medizin*, 1934, in which our original concept for special cases of extreme values of conductivity, dielectric constants, was enlarged upon. This is of importance in regard to the layer arrangements of fat-muscle tissue.

I should like to call attention briefly to the fact that the optimal wave lengths for

Later, I made numerous experiments on muscle-fat phantoms, which approximated the true body volumes in collaboration with regard to the size of phantom, arrangements of electrodes, position of glass-benzol thermometer, etc. Figure 3 shows

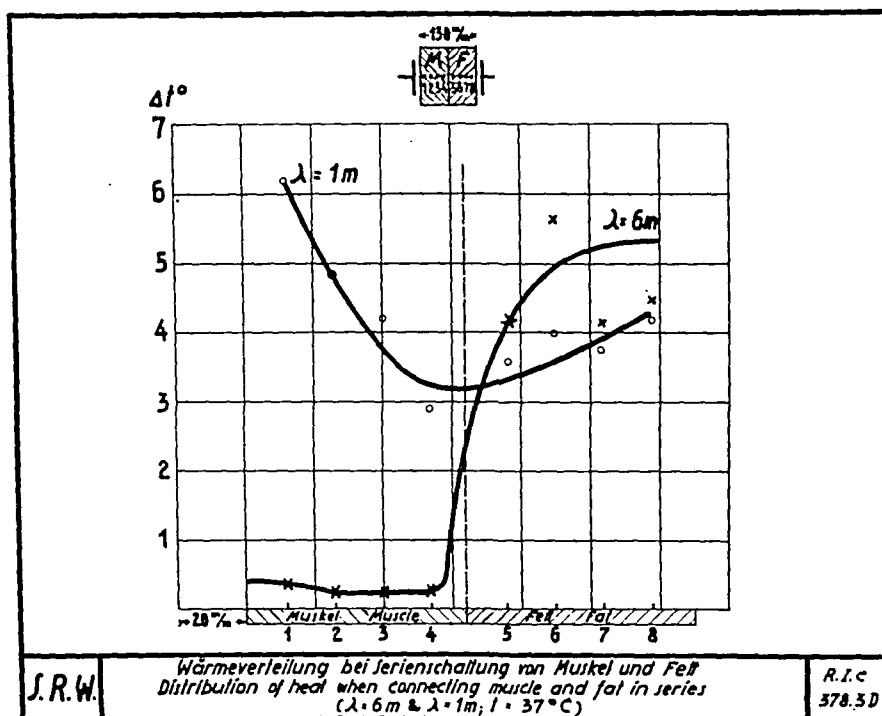


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# THE ROENTGEN DIAGNOSIS OF RETROCECAL APPENDIX

By FRANK E. BUTLER, M.D., and IVAN M. WOOLLEY, M.D., *Portland, Oregon*  
From the Department of Radiology, University of Oregon Medical School

MUCH has been written about the use of the roentgen ray in the diagnosis of appendicitis. Certain writers are of the opinion that a failure to obtain a filling of the appendix is pathog-

they do not represent the chief usefulness of the roentgen ray in this particular field.

The surgeon finds but little use for the x-ray in the diagnosis of appendicitis, except in those cases in which the symp-

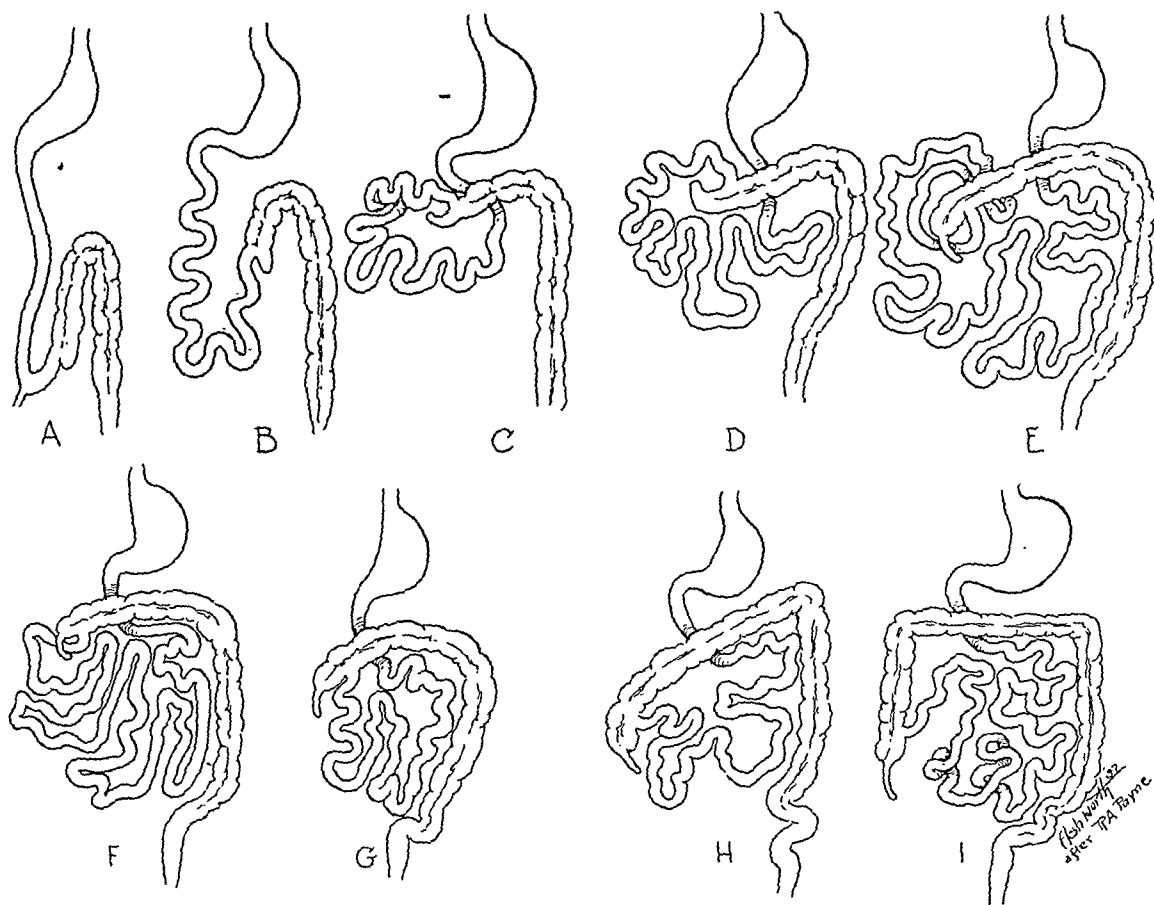


Fig. 1. Series of schematic figures illustrating stages in rotation of the intestinal tract. (From Huntington.)

nomonic of appendiceal pathology. Others have held that a patent lumen which readily admits the barium solution and permits a good filling of the appendix is not normal. Some place great stress upon a fragmented filling as an indication of pathology. Any and all of these points may be of value when properly fitted to other clinical and physical findings, but

toms do not clearly point to that diagnosis. Inflammatory pathology of the gall bladder, pelvic organs, or kidney occasionally simulates the symptoms of appendicitis and at times the reverse is also true. Congenital bands or other abnormalities, when present, may obscure the diagnosis and in such cases a roentgen examination will frequently reveal information of value,

by visualizing abnormalities and localizing the point of greatest tenderness.

Developmental rests of the cecum are a common cause of disturbed relationship in the right side of the abdomen and a hasty

small gut begins the forming of the primitive fold, while the large bowel is draped over it, in something approximating the later position. Next, the relative increase in the size of the body cavity permits the return of the gut. The small intestine is the first to return, and

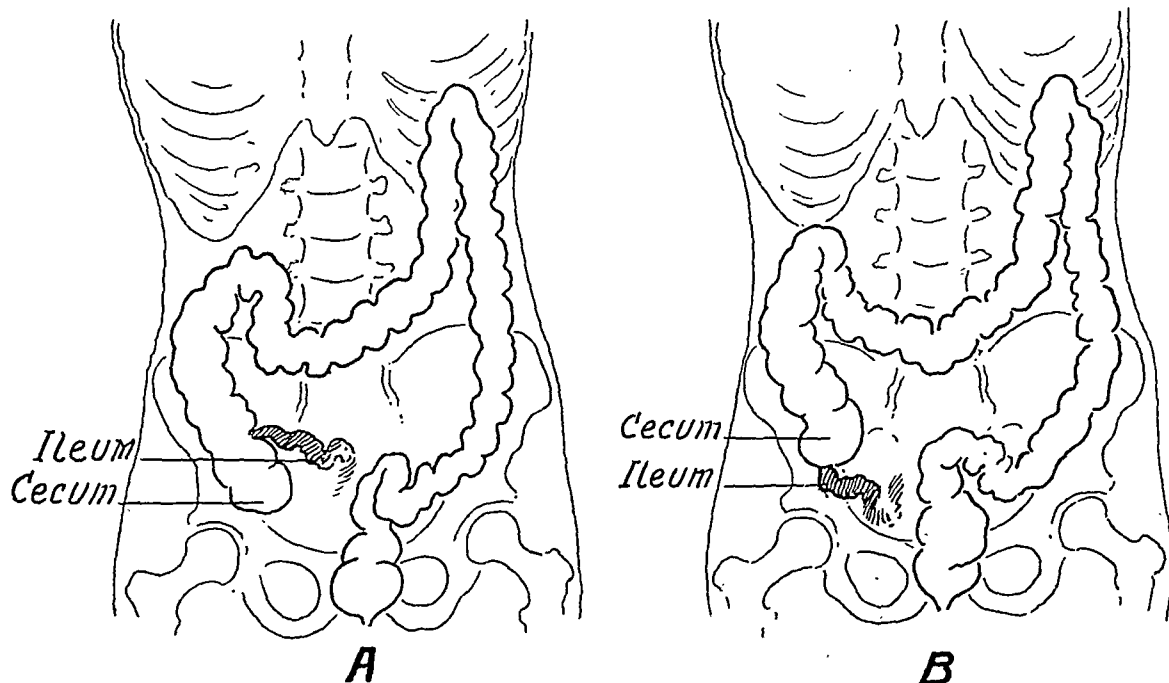


Fig. 2-A. Illustrating the normal relationship of the distal ileum to the cecum.

Fig. 2-B. Illustrating the apparent relationship of the ileum to the cecal tip when the ileocecal valve and appendix are in a retrocecal position. (Drawn by F. C. Trahar.)

review of the embryological changes in the development of the colon may be helpful in refreshing the memory. Payne and Trahar (1) have summarized these changes and this summary so aptly fits the present discussion that we can do no better than to quote from it.

"In Figure 1-A, we take up the position of the stomach and intestine at approximately the fifth week of fetal life. The primitive gut here lies in the mid-line, is attached to the umbilicus, and the cecum is beginning to show as a bud on the parietal portion of the gut. Two factors are prominent in later changes: first, the relative rapidity of the growth of the different parts of the gut, and second, the size of the other organs, particularly the liver, relative to the size of the body cavity.

"As the liver at this stage rapidly increases in size, the bowel is pushed out of the celom into the umbilicus. Here the rapidly growing

the large bowel follows, taking up the position shown in Figure 1-B, still later being pushed by the coil of the small intestine into the upper right quadrant (Figs. 1-C and 1-D). Attention should be drawn to the fact that, at this stage, the small intestine is entering from the right and above.

"*Rotation.*—The migration of the gut is now practically at an end. Figures 1-F and 1-G illustrate the next change, that of rotation resulting in the entrance of the small bowel on the inner side, or from the left and below.

"*Descent and Fusion.*—The real growth of the cecum begins at this stage, and in the later month of the fetal life, and the first month after birth, the growth of the organs carries it and the ileocecal valve into the right lower quadrant, and the fusion of the various mesenteries results in its final position (Figs. 1-H and 1-I)."

Failure to complete these various steps of development leads to the occasional



placement of the appendix in situations that may complicate the diagnosis if the appendix should become pathological and also may interfere with the customary surgical attack. It is in such cases that the roentgen ray can best aid the surgeon and render real assistance to the patient. Because the exact location of the appendix can be determined before operation, the surgeon can more accurately plan his attack and thereby reduce the shock and discomfort to the patient.

It is not the purpose of this paper to review all the technical procedures that are used in the roentgen examination of the appendix: these are well known to all. We do hope to lay stress upon the relationship of the distal ileum to the cecum, as observed radiographically, as an important diagnostic point.

The routine 12-hour meal oftentimes reveals the appendiceal outline, but it as often fails to give enough filling of the cecum to illustrate the presence or absence of rotation. Likewise, the opaque enema may give an excellent outline of the cecum, but fail to outline the appendix. In cases in which the appendix fills, the observer may draw fairly accurate conclusions, but when no outline is obtained the diagnosis must pass into the field of conjecture.

Figure 2-A illustrates the usual relation-

ship of the distal ileum to the cecum. The barium has completely filled the cecum and has passed into the distal ileum, which is seen to be attached on the medial side of the cecum. This illustrates a normal relationship between the ileum and cecum. In Figure 2-B, we find the ileum coming not from the medial side of the cecum, but appearing to come from the cecal tip. Attempts at manipulation fail to alter this appearance. When such a pattern is revealed we know that we are dealing with an incompletely rotated cecum and that the ileocecal valve and the appendix must be in a retrocecal position.

In our personal experience we have found this observation to be of great value in the diagnosis of retrocecal appendix. In certain cases it has been the only finding of any value in the roentgen diagnosis. During the past many years we have had occasion to follow a great number of these patients to surgery and have seen the accuracy of the observations demonstrated. We have come to look upon it as a pathognomonic sign, and, therefore, we feel justified in making it the basis of this report.

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# METHODS USED TO ATTAIN HIGH SPEED IN ROENTGENOGRAPHY

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**A**N important problem in roentgenography is to obtain sharp shadowgraphs of moving objects, in particular of the heart and lungs in living persons. The solution of this problem involves taking roentgenograms with extremely short exposure times. By thus reducing to a minimum the blurring due to the motion of the object during exposure, the quality and detail of the x-ray film is greatly enhanced. The conventional way of decreasing exposure time is to increase the x-ray tube current (milliamperage) but there is a rather definite limit to which this can be carried. The limiting factors depend upon the rating of the x-ray tube focal spot and the load-carrying capacity of the supply line. Larger currents through the x-ray tube, even though applied only momentarily, require high voltage transformers with heavy windings to reduce ohmic resistance, and a supply line of large current-carrying capacity. Such heavy loads are generally limited to three phase systems.

The heavy loads and violent surges on the supply line and x-ray transformer can be eliminated by using condensers to store the energy required for making an x-ray shadowgraph. The condensers are charged slowly through rectifiers over an interval of several seconds, and then discharged rapidly through the x-ray tube in a small fraction of a second. The capacitance of the condenser must be such that sufficient energy is released in a single discharge to produce an x-ray film of satisfactory density. Since electrical energy is drawn from the supply line at a low rate, even small x-ray transformers suffice to charge a set of condensers for high speed roentgenography. Hence a small fluoroscopic x-ray unit may be converted into the most powerful roentgenographic machine.

*Types of Controls Used to Discharge Condensers.*—Perhaps the most simple method of discharging the condenser is through a sphere gap. With the x-ray tube filament set to emit a current of approximately 1,000 milliamperes, the condensers are charged to their predetermined voltage and then discharged through the gap. An appreciable amount of noise always accompanies the discharge, but due to the effective impedance of the x-ray tube being in the neighborhood of 80,000 ohms, it is not excessive. Even this noise is undesirable and unnecessary and would certainly frighten a patient unless the noise were muffled. An improvement is accomplished by immersing the sphere gap in an oil tank and closing the gap under oil. Silent operation can be obtained by using a vacuum switch to excite the x-ray tube. In this device (1) the separation of the electrodes is controlled by a magnetizing coil outside the vacuum chamber. These gaps withstand the total voltage of the transformer during the charging interval. Voltage is applied to the x-ray tube only during the discharge time. In some of the other methods to be described, the x-ray tube must effectively block the flow of electrons throughout the charging period.

The deleterious effect of the steep voltage wave front accompanying a condenser discharge is reduced to a minimum by adding a certain amount of inductance to the discharge circuit. Teillard (2) described a circuit containing an inductance of about 2,000 henrys. In addition to eliminating the steep wave front, this large inductance produced nearly constant potential during the time the x-ray exposure was being made.

A method of controlling the condenser discharge, reported by Bouwers (3), utilizes

a grid placed around the filament of an x-ray tube. A sufficiently negative bias is applied to this grid during the charging

tion current of 1,000 milliamperes, while that of the rectifier tube is capable of passing about twice this current. This is

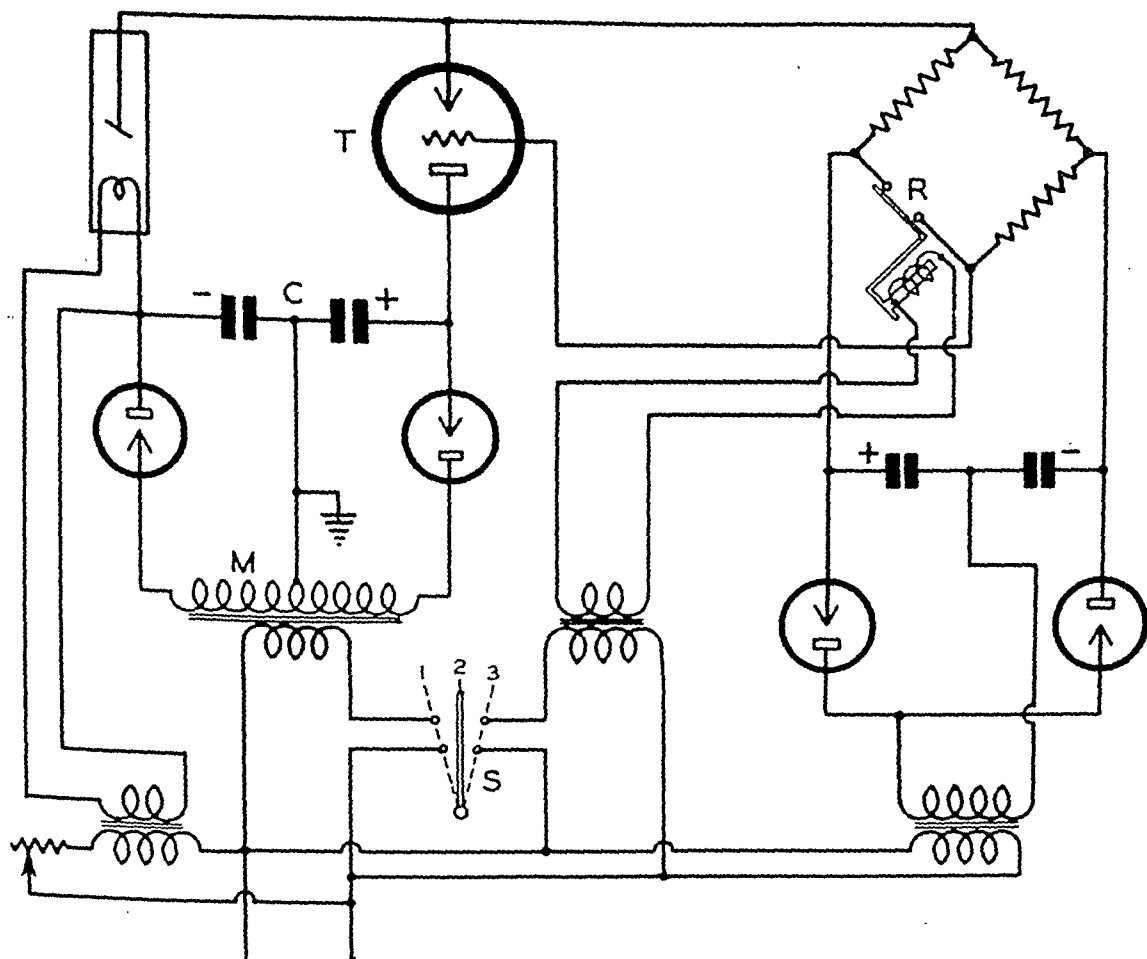


Fig. 1. Condenser discharge through the x-ray tube is controlled by a three electrode tube "T."

period so that very few electrons escape from the filament even though it is at full emitting temperature. To effect discharge, the negative bias is removed or the grid may even be made positive with respect to the filament. High voltage is applied to the x-ray tube during the charging interval as well as during discharge.

A more convenient way of accomplishing the same result is to introduce a grid-controlled rectifier in series with the x-ray tube and high voltage condensers. With this control tube, the circuit of which is described by Morrison (4), the filament of the x-ray tube is heated to give a satura-

necessary to reduce the voltage loss in the control or "trigger" tube to a small value and cause the x-rays to be generated within the x-ray tube. During the condenser-charging cycle a negative potential is applied to the grid of the rectifier tube, which effectively blocks the flow of electrons through both the control tube and the x-ray tube. After the condensers are fully charged an accelerating potential is applied to the grid which permits the passage of high currents through the x-ray tube with relatively low voltage loss in the control tube. The steepness of the wave front accompanying the condenser discharge is

controlled by the rate at which the grid potential is shifted from a negative to a positive value. The time required for

celerating potential applied to the grid of the "trigger tube" by the relay switch, *R*, causes the flow of electrons through the

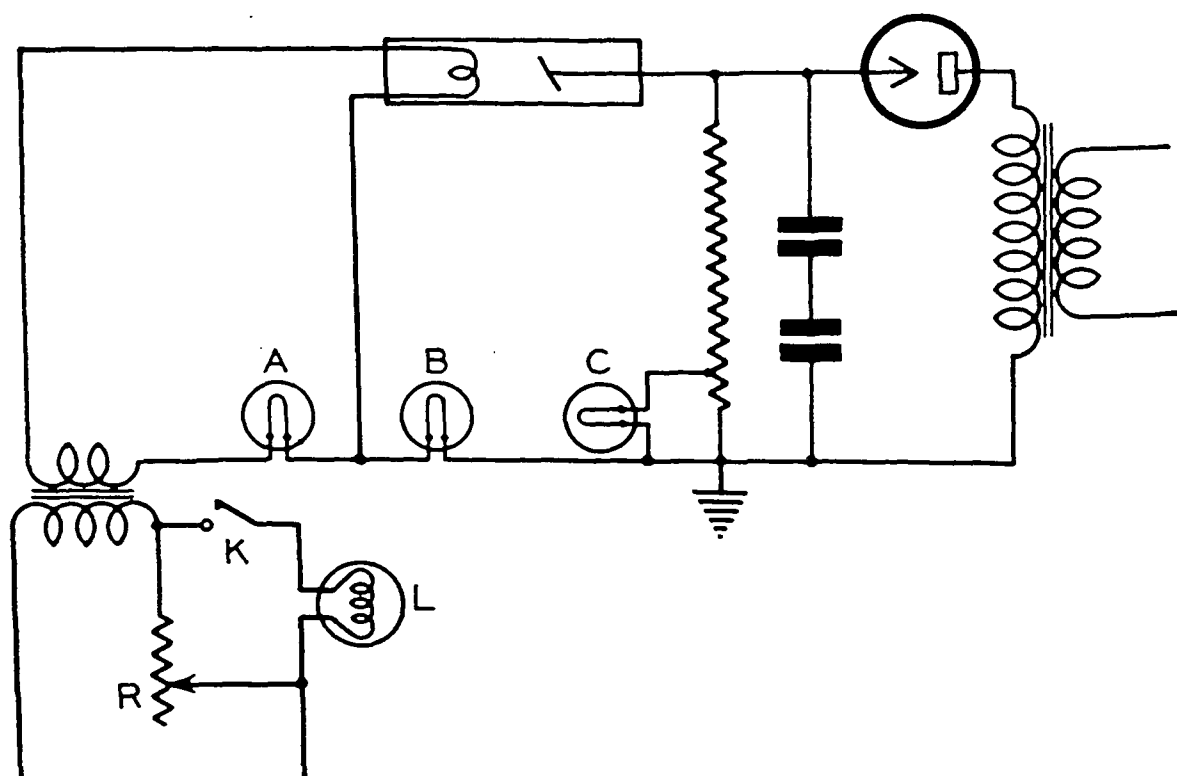


Fig. 2. Condenser x-ray machine with lamp filament control "L."

current to reach its maximum value is of the order of a few thousandths of a second. The time of condenser discharge depends upon the capacitance of the condensers, the voltage to which they are charged, and the rate at which electrons are emitted by the x-ray tube filament. This is of the order of from 0.02 to 0.10 second.

Figure 1 shows the electrical circuit of the condenser x-ray machine controlled by the "trigger tube." Closing the switch, *S*, to position, 1, causes a negative potential of several thousand volts to be applied to the grid of the control tube, *T*, while the main condensers, *C*, are being charged. In the neutral position, 2, the high voltage transformer, *M*, is disconnected from the supply line while a negative bias still prevents the discharge of condenser *C*. With the control switch in position, 3, an ac-

x-ray tube and the almost instantaneous generation of x-rays. The Wheatstone network associated with the biasing unit permits a change in polarity from negative to positive without opening the circuit to the control grid.

An interesting method of controlling the discharge of the condenser is given by Niemann (5), wherein no accessory equipment is required. The filament of the x-ray tube is maintained at such a low temperature during the time the condensers are charged that thermionic electrons are not given off. To discharge the condensers, part of the regulating resistance in the filament supply circuit is shorted out. This permits the filament to attain its predetermined electron-emitting temperature and so drain the charge of electricity from the condenser. Due to

the heat capacity of the x-ray tube filament, an appreciable time elapses before the maximum current is attained, and so the discharge time is quite appreciable.

A marked improvement in discharge time is obtained by a novel modification introduced by Ulrey (6). The principal features of this method are indicated in Figure 2. The high voltage transformer, rectifier tube, and condenser form the charging circuit. The discharge circuit consists of the x-ray tube and condenser. Oscillograph elements *A*, *B*, and *C* were introduced to observe photographically the transient phenomena occurring during the interval in which x-rays were produced. The filament-lighting transformer of the x-ray tube has a secondary winding of low ohmic resistance to permit over-shooting of the x-ray filament current. The regulation in the primary supply line consists of a nichrome wire resistor, *R*, and a tungsten filament lamp, *L*. Resistance *R* is of such size that the filament is heated below the electron-emitting temperature. The lamp filament *L* is so chosen that when the short circuiting key, *K*, is closed, the final current is such that the maximum predetermined electron emission is obtained from the filament of the x-ray tube. At room temperature the resistance of the tungsten filament in the control lamp is only about one-tenth its final value. Hence, when key, *K*, is closed, the momentary current through the x-ray filament is several times its final equilibrium value. This over-shooting of current heats the filament of the x-ray tube very rapidly and permits practically instantaneous x-ray exposures. The x-ray tube suffers no deleterious effect since the large filament current is applied only during the time the lamp filament *L* heats to its final temperature—a time of less than one second. The heat capacity of the filament is sufficient to reduce the steepness of the wave front of the condenser discharge so that violent surges do not appear in this circuit.

Several other methods might be used in discharging a condenser through an x-ray tube. One is to put an overload relay or a

fuse of proper size in the filament circuit of the x-ray tube and then overheat the filament by excessive voltage until the fuse opens the circuit. The size of the fuse is calculated to permit the filament to heat rapidly for a short time only, during which time the condenser is drained.

Dessauer (7) described a circuit in which a fuse was placed in the primary of the high voltage transformer that was momentarily overloaded. As soon as the fuse opened the circuit a heavy surge was passed through the secondary windings of the transformer and x-ray tube. This produced an instantaneous x-ray exposure. He used a gas-filled x-ray tube.

Another method is to pass the energy from a low voltage condenser through the x-ray tube filament. The momentary overheating of the filament will discharge the main condensers through the x-ray tube.

It is also possible to use a vapor- or gas-filled control tube in series with the x-ray tube and high voltage condensers. Tubes of the grid-glow or thyatron type might be adapted to high voltage use.

A magnetic field might be employed to confine the electrons from the filament to the cathode of the x-ray tube. At the desired moment the magnetic field is reduced to permit the normal flow of electrons through the x-ray tube. This scheme is very difficult to accomplish in a practical manner.

#### *Data Obtained with an Oscillograph.—*

An oscillograph gives very desirable information on the speed and magnitude of the transient phenomena occurring during the discharge cycle. Much data can be obtained with a multi-element oscillograph on a single condenser discharge. The circuit of Figure 2 is used to illustrate the type of data obtained with an oscillograph. An element connected at *A* indicates the change in filament current, the element at *B* depicts the flow of current out of the condenser and through the x-ray tube, while an element connected as at *C* indicates the rate at which the voltage across the x-ray tube falls.

Figure 3 is a reproduction of an oscillogram record taken of conditions during filament current trace and in the tube discharge in the circuit of Figure 2. The ripple in the latter trace is due to the intermittent heating of

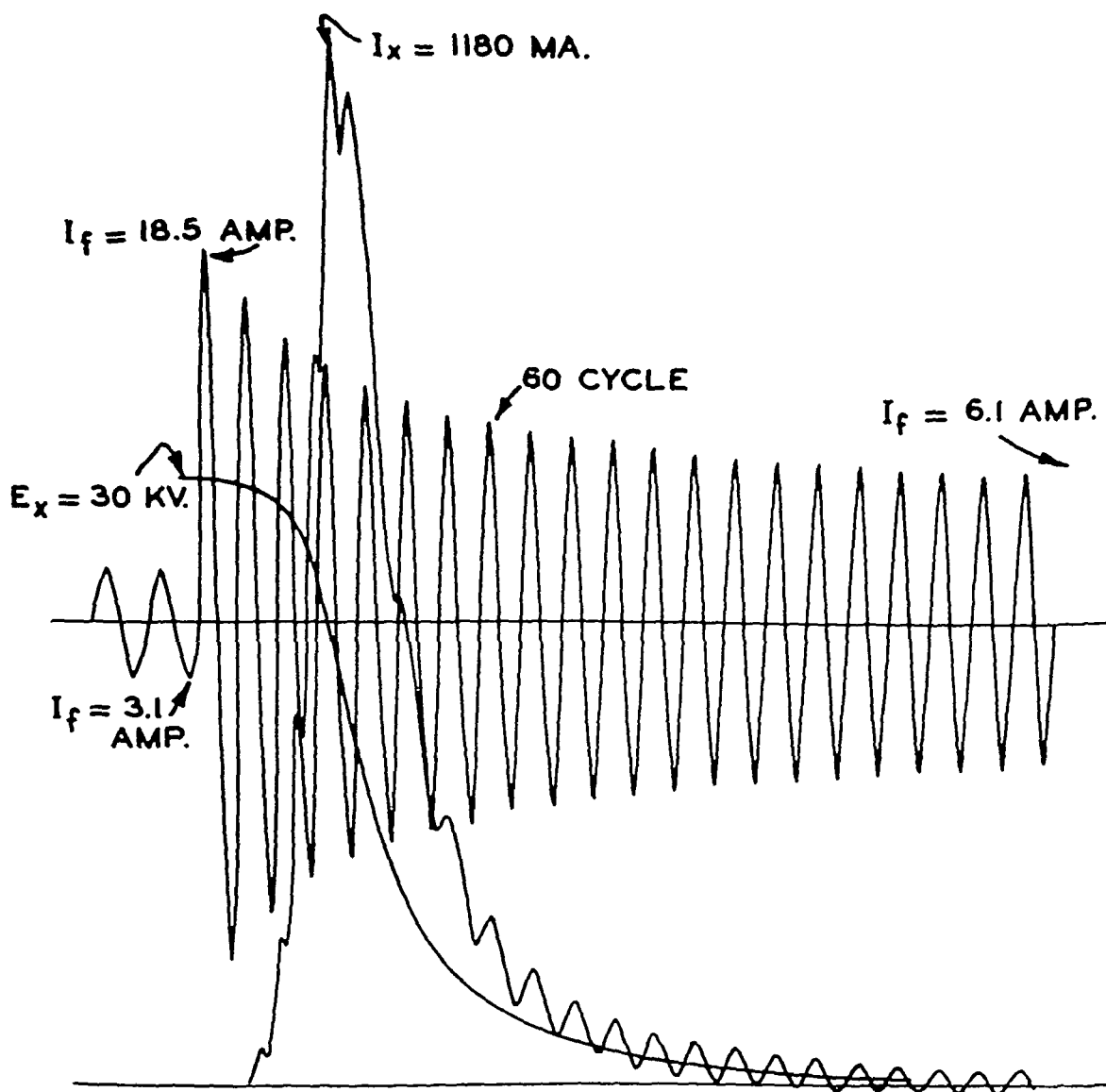


Fig. 3. Oscillogram record obtained from the circuit of Figure 2. The transient phenomena in filament current  $I_f$ , condenser voltage  $E_x$ , and x-ray tube current  $I_x$  are depicted.

x-ray tube filament current  $I_f$  changed from its steady state of 3.1 amperes to a maximum of 18.5 amperes, and then to a steady state of 6.1 amperes in an interval of less than one second. The condenser of 2 mf capacity was charged to 30 kv. ( $E_x$ ) initially, and the maximum tube current ( $I_x$ ) was 1,180 ma. The 60-cycle supply voltage is indicated both in the

the x-ray tube filament by the 60-cycle current.

The oscillogram applied to other circuits, indicated in the preceding paragraphs gives information showing characteristics of each of the control devices. For example, with the sphere gap, a high frequency surge accompanies the initiation of the discharge if there is insufficient

inductance in the discharge circuit. This surge places an excessive strain both on the x-ray tube and on the entire discharge

posure time. Since all the various schemes used in controlling the condenser discharge involve transient phenomena, the maxi-

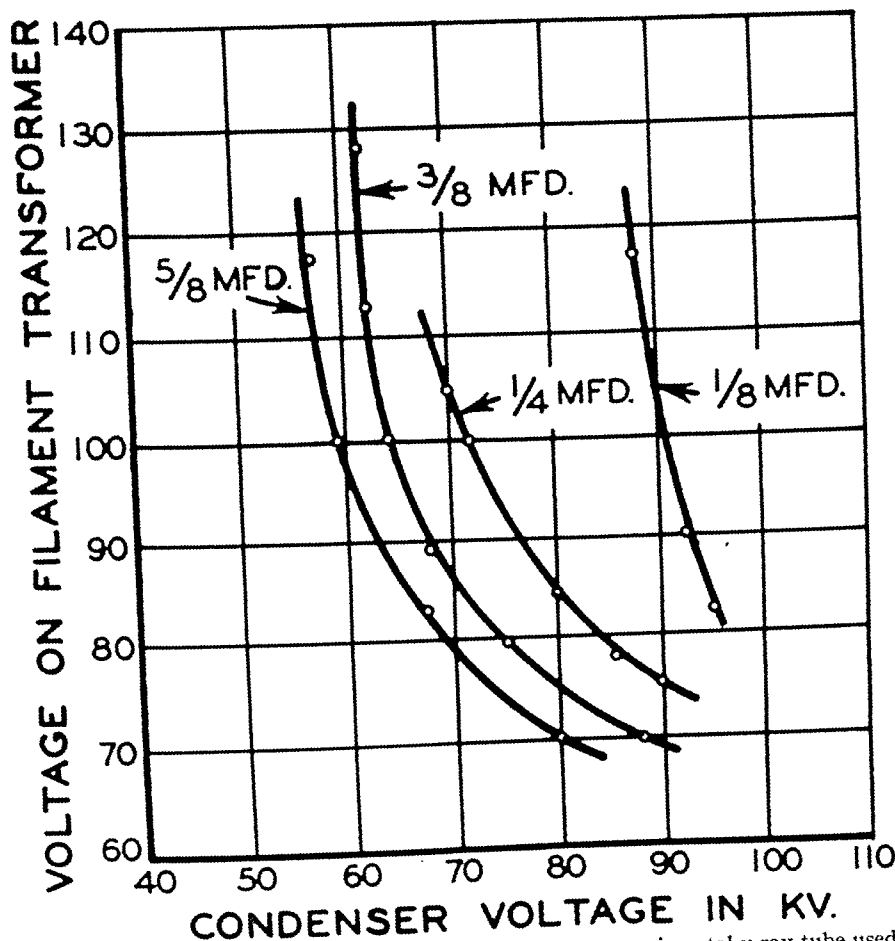


Fig. 4. Filament settings for stable operation of an experimental x-ray tube used in the circuit of Figure 2.

circuit. With the proper amount of inductance the current and voltage waves are smooth and free from high frequency oscillations. Bouwers (8) reports that with an inductance of 2,000 henrys the voltage wave is very round and broad at the top and gives nearly constant potential. Oscillograms readily show the difference in discharge time by substituting a tungsten lamp filament for nichrome wire resistance. Figure 3 shows an abrupt initiation of current through the x-ray tube, while if a nichrome wire resistor is substituted for the tungsten filament lamp, the increase in the tube current to its maximum value is slower and hence entails a longer ex-

posure time. Since all the various schemes used in controlling the condenser discharge involve transient phenomena, the maxi-

imum efficiency and proper operating conditions are best attained by use of the oscillograph. The speed of the condenser discharge in Ulrey's (6) method is controlled by changing the voltage applied to the filament-lighting transformer, once the fixed resistor and lamps have been selected. Different settings are necessary to compensate for variations in x-ray tubes having different sizes of focal spot, and for variations in the condenser capacitances. Figure 4 shows the relation between the voltage applied to the filament-lighting transformer and condenser voltage for various condenser capacitances. These curves in-

dicates the optimum operating conditions for one experimental x-ray tube. Actual chest films were taken with a condenser proper thickness to regulate the maximum film opacity and by selecting a suitable speed of rotation for the disk, the records

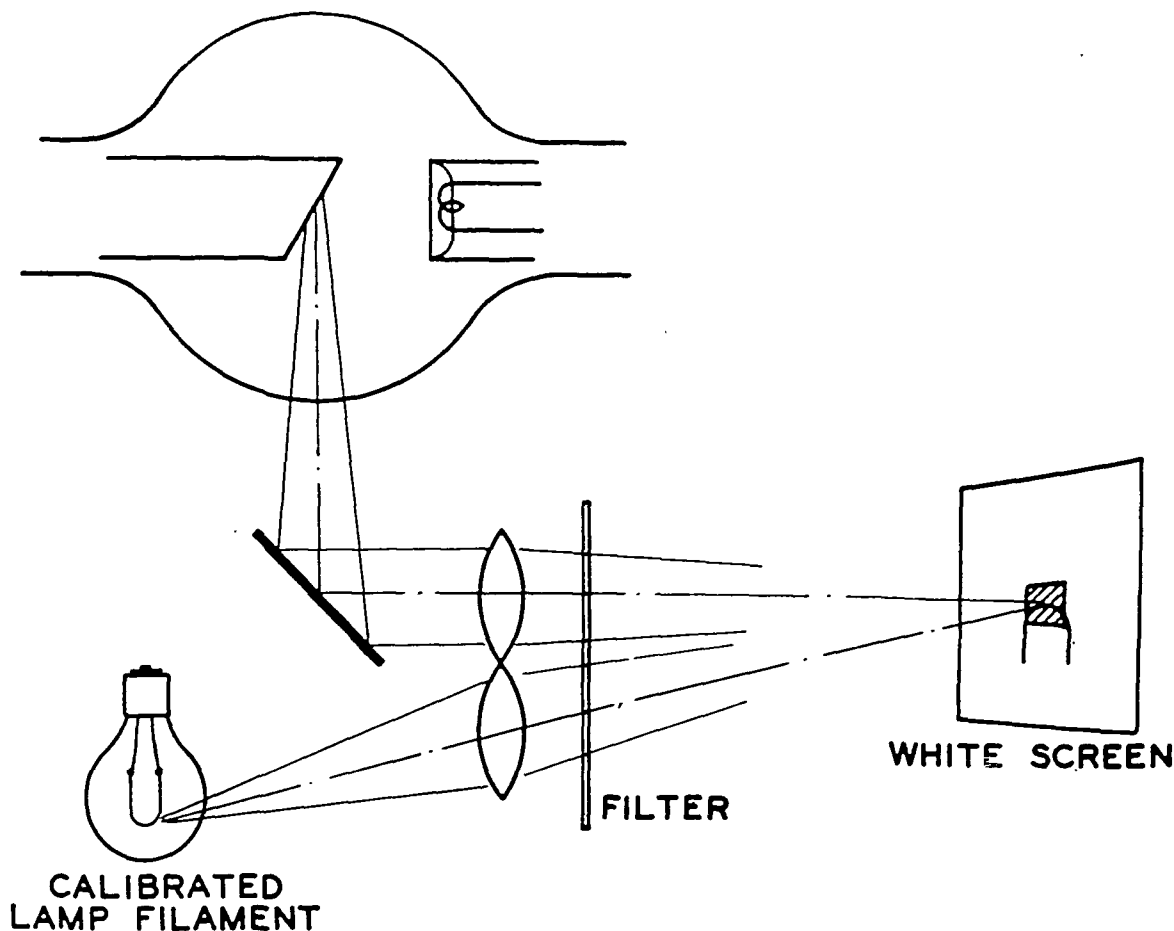


Fig. 5. Simple apparatus for matching the maximum instantaneous focal spot temperatures with a calibrated tungsten filament.

capacity of  $\frac{1}{4}$  mf and voltages of from 60 to 70 kv. The quality of the roentgenographs was very good, the effective exposure time being about  $\frac{1}{40}$  second.

*Discharge Speeds Measured with a Rotating Disk.*—Although the time of condenser discharge can be readily measured on the oscillograph records, a rapid and convenient method of making estimates of this quantity can be obtained with a rotating disk. A disk, one half of which is transparent to x-rays and the other half opaque, is caused to rotate above a photographic film during the condenser discharge. With an aluminum filter of

have one section completely transparent, one of maximum film blackening, and two sections showing a gradual shading of darkness to transparency. A certain amount of filtering is desirable to give the film a maximum density about equal to that of a diagnostic x-ray film. Too much filtering indicates too short an exposure time, while too thin a filter greatly exaggerates the effective condenser discharge time. By measuring the angle over which the gradation of film blackening is observable, one can calculate the speed of condenser discharge. A protractor is generally sufficient for approximate time de-



terminations, but a densitometer tracing made from the rotating disk record will give greater accuracy. Measurements of time made by the interval from initiation of discharge to some arbitrarily chosen point such as 95 per cent of maximum blackening give very uniform and comparable results.

*Focal Spot Temperature Measurements.*—Even though the time of x-ray exposures can readily be determined with an oscillograph or rotating disk, it is very necessary to know that the maximum temperature of the focal spot of the x-ray tube anode never exceeds about  $3,000^{\circ}\text{K}$ . Otherwise, excessive evaporation of tungsten or actual melting takes place. Observations on the temperature of the focal spot can be made by projecting the image of the focal spot on a screen together with an adjacent image of a calibrated tungsten filament. The momentary flash on the anode registers its temperature in comparison to that of the calibrated lamp. Figure 5 indicates the simplicity of this measurement. A red filter intercepting the light from both light sources makes color temperature comparisons very easy.

#### CONCLUSION

The chief advantage of using condenser discharges in roentgenography is the reduction of blurring caused by motion. This results in increased sharpness of detail. Other desirable features, such as uniformity of film density in successive exposures, are obtained because exposure timers are eliminated. With a relatively small x-ray transformer, and power lines of low capacity, one can do roentgenographic work equivalent to that done with the largest commercial x-ray machines.

It is a pleasure to acknowledge the assistance of Dr. C. T. Ulrey, with whom some of the experimental work was done.

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tube. Occasionally, with low-lying tumors, the insertion is made blindly by the sense of touch, with the finger within the rectum to guide distribution.

Local rectal applications consist of ap-

holder, containing a number of radon tubes in tandem fashion, sufficient to extend 0.5 cm. above the upper limits and 0.5 cm. beyond the lower limits, is inserted and fixed in position. The radium is

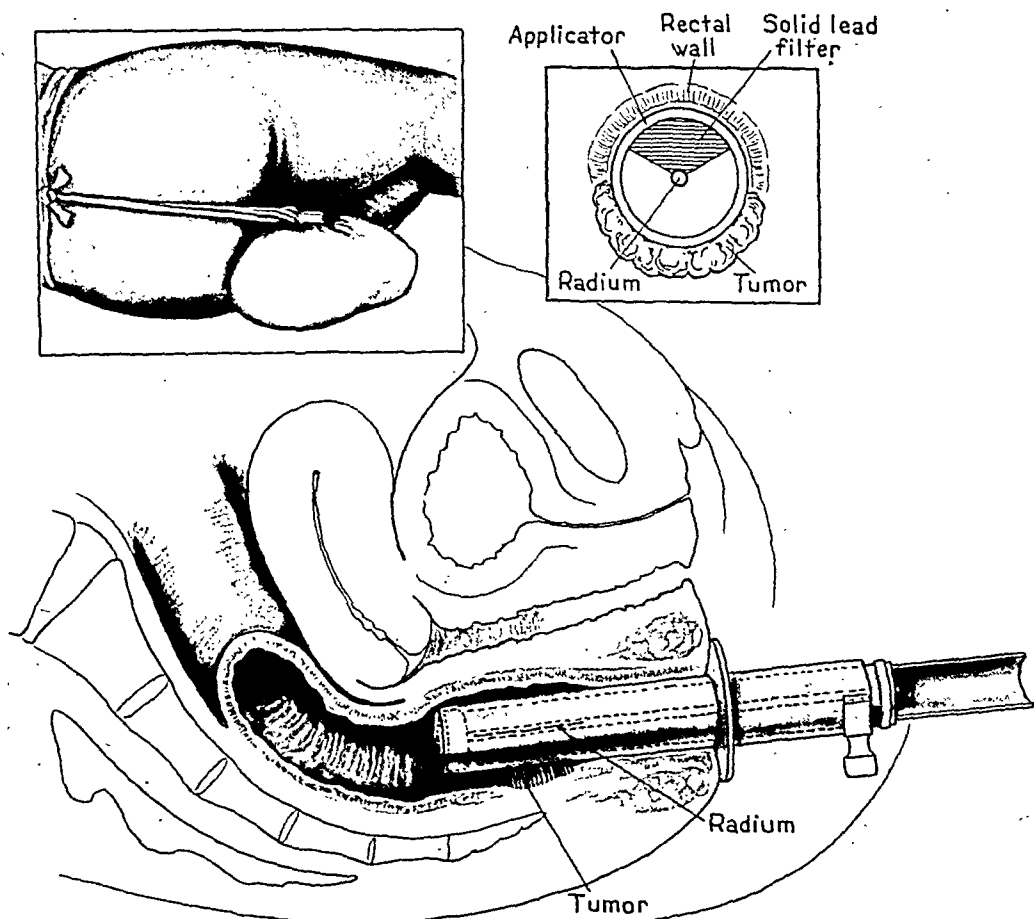


Fig. 2. Rectal applicator in position, radium being administered at 1.25 cm. from the tumor. Insets: applicator held in position; cross-section showing radium with lead filter protecting one-third of the rectal circumference.

plying radon or radium at from 0.75 or 1.25 cm. from the surface of the tumor by means of special rectal applicators. This method has been employed in a small number of the cases here reported. Applicators are fashioned similar to the ordinary proctoscope. They are placed in position by direct vision, or blindly, after careful measurements as to location and size of the tumor have been determined. When the applicator is placed in position the obturator is withdrawn, and the

filtered by 2 mm. of brass. The section of the circumference of the rectum not invaded by tumor is protected by an additional filter of lead, the thickness of which corresponds to one-half the diameter of the applicator. Applications are given daily. The daily dosage appearing most effective varies from 100 to 250 millicurie-hours. Total dosages vary from 2,000 to 5,000 millicurie-hours and require from three to six weeks for completion. The use of fractional dosages of radon to the surface

of the tumor is still in its infancy. More time and an increased number of cases will be required before the true worth of this method can be definitely determined.

Colostomy is seldom required when ra-

perior to those obtained in 1925, when gold-filtered radon seeds were first employed in the treatment of this disease.

*Personal Cases.*—From 1925 to 1935, inclusive, 65 so-termed operable cases have



Fig. 3. Roentgenogram of pelvis following the implantation of gold seeds into a small rectal cancer.

diation therapy is employed in primary operable lesions. Only when obstruction is a troublesome factor, due either to disease or secondary contraction of indurated tissue, need the operable patient be subjected to this procedure. During the early years of treatment considered in this report colostomy was done in about 50 per cent of all cases, but during the past five years it has seldom been employed.

#### RESULTS

The results so far obtained by radiation therapy in operable rectal cancer are encouraging. Present-day results appear su-

been treated by this method. During the same period, 119 patients were subjected to radical surgery. Of the 65 patients treated by radiation therapy, there were 37 males and 28 females. Six of these patients refused radical surgery and 12 patients were classified as very poor surgical risks. Local disease was extensive in 21 cases and in 12 of these the condition had reached the advanced borderline operable stage.

It is quite evident from this review that the best results are obtained in early operable lesions. In the series of 65 cases, there were 19 large, 28 medium, and 18

small tumors. A large tumor signifies advanced disease with varying degrees of fixation, medium sized tumors represent well-established disease, with or without moderate degrees of fixation, while small tumors vary in size from 1 to 4 cm. in diameter and are freely movable.

Of the 19 patients with advanced disease, 12 are dead and seven are alive. Of the 12 patients who died, two were considered to be free and ten were thought to have cancer at the time of death. Of the seven patients living, two are thought to have disease, while five are considered to be clinically free of disease. One of the living patients has remained well for two years while the other four have enjoyed freedom from disease for periods varying from five to nine years.

Results from the treatment of medium-sized tumors have been somewhat more encouraging. Of the 28 cases treated, there have been 16 satisfactory results to date. Eighteen of the 28 cases are dead, while ten are alive and clinically free of disease. Treatment of six of the patients was quite satisfactory; they have since died, three of them of intercurrent disease without recognizable cancer, one year eleven months, four years, and six years, respectively, after treatment. The status of disease in the fourth patient at the time of death, five years eight months after treatment, is unknown. The fifth patient lived six years and eight months, dying with lung metastases without local recurrence. The sixth patient, who refused surgery, was free of disease for five years and six months.

The most gratifying results to date have been with the small tumors, of which there were 18 subjected to irradiation. Three of these patients are dead. One died three years after treatment with metastases in the liver, without recognizable cancer in the rectum. Another died ten years after treatment, at the age of 84, and the third lived seven years and died without recognizable cancer in the rectum. The remaining 15 patients are alive and considered clinically free of disease, the periods of

freedom varying from 15 months to 10 years.

Sufficient time has not elapsed to afford a definite determination of the final results of radiation therapy in a large series of operable rectal cancer. However, more than five years have elapsed since 34 of the above patients were treated. In this group of 34 cases, radiation therapy was supplemented by colostomy in 18 instances (53 per cent), while 16 patients were not subjected to any form of surgery. Seventeen of the 34 patients (50 per cent), survived the five-year period; nine of them are still alive and clinically free of disease, five and one-half to ten years later. Three of those not living died of intercurrent disease without any evidence of their original condition. The length of life of those now dead varied from three months to ten years.

In the remaining 31 cases which have been treated by radiation therapy within the five-year period, colostomy was employed in only three instances, or less than 10 per cent. Eight of the 31 patients are dead; one dying of intercurrent disease, and seven with cancer. Twenty-three are alive, 21 of whom are considered clinically free of disease, the periods of freedom varying from one year three months to four years six months.

#### CONCLUSIONS

Radiation therapy, with our present technic of application, occupies an important position as a selective method of treatment for operable rectal cancer. It is capable of producing long-standing clinical cures, and is suitable for large, medium, and small lesions. The highest percentage of good results is obtained in the early localized cancers. The advantages afforded by this method of treatment are: (1) short periods of hospitalization, (2) avoidance of the dangers and inconveniences of radical surgery, and (3) the retention, in most instances, of a normally—or practically so—functioning rectum.

# CARCINOMA OF THE CERVIX: MORTALITY REDUCTION<sup>1</sup>

By WRIGHT CLARKSON, M.D., and ALLEN BARKER, M.D., *Petersburg, Virginia*

CANCER of the cervix accounts for nearly 20 per cent of all deaths from cancer in women; and our observations agree with those of Norris (1), who thinks that a cross-section of all cases of carcinoma of the cervix will show five-year survivals of not over 10 per cent. When one considers the fact that five-year survivals of well over 50 per cent have been reported following proper radiological treatment of large series of moderately advanced cases, it becomes obvious that the number of deaths can be greatly reduced by more effective application of our modern methods of treatment.

Inadequate knowledge of cancer and geographic inertia afflict both the average physician and the general public. The only way to meet this condition seems to be to bring trained oncologists and facilities for treatment to as many localities as possible. This could well be accomplished by the formation of numerous small rotating clinics. Through close co-operation with the local medical societies everywhere, clinics can carry cancer control to the laity and to the physicians. These clinics should be conducted only by those who are thoroughly trained in the diagnosis and treatment of neoplastic diseases. The establishment of cancer clinics stimulates the demand for specialization in oncology and there is no field of medicine where intense specialization is more urgently needed.

A definite cancer diathesis is inherited by many persons, and this is one of the chief causes of the present death rate from this disease. Genetics, therefore, may eventually play an important rôle in the prevention of cancer. It is also possible that some day there will be discovered a way of increasing an individual's resistance to this

disease by inoculation or otherwise; but no material reduction of mortality seems likely to occur from either of these methods in the very near future.

Our present methods of prophylaxis and treatment of cancer of the cervix, however, are practicable and comparatively effective, and the mortality rate can be materially lowered if we combine the educational factors with the scientific aspects of the problem. Women everywhere must be taught to regard leukorrhea and any other unusual change in the character or amount of their vaginal discharge as significant of some abnormal condition which demands immediate investigation and treatment. Physicians must be impressed with the necessity for making frequent and careful examinations of the cervix as a routine procedure; and both laymen and physicians must be convinced of the fact that cancer patients can be properly treated only by those who are thoroughly trained in oncology.

Since a benign disease of the cervix usually precedes actual cancer of the cervix, every physician should be on the outlook for abnormal conditions of this structure, and the lesions should be diagnosed accurately and treated promptly.

Among the methods that have been used in the treatment of precancerous conditions of the cervix, electric coagulation has been found the most effective, and in carefully selected cases, in women at or about the menopause, external irradiation to the pelvis is a valuable aid. In view of our present knowledge of the action of the ovarian hormones, it is reasonable to believe that pelvic irradiation, properly administered, is also a good prophylactic measure against cancer of the body of the uterus and against cancer of the breast.

Of utmost importance in the treatment of all neoplasms is the fact that cancer

<sup>1</sup> Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

usually, if not always, begins as a local disease, and that it kills seldom by direct extension but more often by metastases. The trauma which necessarily accompanies any forceful physical examination, biopsy, or other operation, may favor this transplantation; and it is logical to believe that properly irradiated malignant cells are less likely to form metastases, should they be so disseminated.

Although the importance of pre-operative irradiation seems to be well established, its value is not fully appreciated by many physicians who regularly make forceful bimanual pelvic examinations under anesthesia, take biopsy sections, dilate and curette the malignant uterus, and then force a radium capsule into place with no attempt to give the patient irradiation prior to these traumatizing operations.

In older women, non-traumatic irradiation should be given in the form of roentgen therapy, but in young women, sufficient pre-biopsy irradiation can be given by using a lead protector in which a thinly filtered radium pack is brought in close contact with the tissue to be removed.

The old saying that ten cents' worth of radium may do a million dollars' worth of injury is figuratively true, but this warning seems not to have been effective. Radium is widely heralded to-day as a great blessing to patients with cancer, particularly to those with cancer of the cervix. But in reality, it is being so frequently misused in the treatment of this condition that, at present, the number of patients who are needlessly rendered incurable by radium therapy is far greater than is the number of patients being cured by the treatment.

The treatment of cancer of the cervix is now generally conceded to be essentially a radiological problem, but surgeons and other physicians untrained in the science of radiology are treating far more of these cases than are qualified radiologists. Therefore, it is necessary to make it more widely known that effective irradiation cannot be expected more than a few centimeters away from the point of radium application, that malignant cells become radio-

resistant when so inadequately irradiated, and that curable cancers are often thereby rendered hopeless.

By properly combining roentgen and radium therapy, Coutard (2) and his co-workers have obtained striking results in the treatment of their cases. They report five-year cures of 75 per cent in the early cases, degree I; 56 per cent in the moderately advanced cases, degree II, and 36 per cent in the far advanced cases, degree III.

Most competent radiologists are now using some quite similar methods of external irradiation followed by prolonged intra-cavitary radium therapy, but the fact that some aspects of the treatment are surgical in nature, that hundreds of unattached surgeons own radium, and that the giving of roentgen irradiation prior to the radium therapy considerably increases the expense of the treatment, all greatly complicate the problem, and often prevent the employment of the best method of treatment. This makes it desirable to establish numerous endowed cancer clinics with proper personnel and equipment for the modern treatment of cancer of the cervix.

#### SUMMARY

1. Five-year survivals of all cases of carcinoma of the cervix treated to-day do not exceed 10 per cent, yet five-year survivals of well over 50 per cent may be obtained by the proper use of external irradiation as the first act, followed by proper intra-cavitary irradiation.

2. Travelling cancer clinics working in co-operation with local medical societies should carry cancer control to the laity and to physicians.

3. Women everywhere should be taught to seek medical advice early for all abnormal vaginal discharges, physicians should be taught to make frequent and more careful examinations of the cervix, and both the laity and physicians should be taught that cancer of the cervix can be properly treated only by oncologists.

4. Electric coagulation and irradiation, in selected cases, are effective in the treatment of precancerous lesions of the cervix.

5. Non-traumatic irradiation should be given prior to all forceful examinations and biopsies, and prior to the intra-cervical use of radium.

6. Radium is so frequently misused today that the number of cancer of the cervix patients who are rendered incurable thereby is far greater than the number being cured by radium therapy.

7. The economic factor makes desirable the establishment of numerous endowed clinics for the treatment of cancer of the cervix.

#### REFERENCES

- (1) NORRIS, CHARLES C.: Personal communication. March 16, 1937.
- (2) COUTARD, HENRI: Personal communication. Feb. 13, 1937.

# CASE REPORTS AND NEW DEVICES

## A NOTE ON SHOCK-PROOF TUBES IN LOW VOLTAGE THERAPY

By CARL E. NURNBERGER, *Peiping, China*

From the Department of Radiology, Peiping Union Medical College

The introduction of a new type of x-ray equipment always raises the question of x-ray intensity and quality of the new as compared to the old equipment. In the case of the new G. E. SP 1-4 shock-proof unit and the old G. E. Universal type tube, it can be said that the intensity and quality of the x-rays from them are different, but the biological reactions of equal doses in roentgens are clinically alike.

The permanent filter of the SP 1-4 shock-proof unit is greater than the permanent filter of the Universal tube. X-ray quality, and therefore depth intensities, depend on not only filtration but also wave-forms of the applied voltage. Comparisons of the x-ray emissions should therefore be based on tests of the tubes with the same high tension generator.

In September, 1936, the department of Dermatology at the Peiping Union Medical College replaced a Universal type tube with an SP 1-4 shock-proof unit. The half-wave high tension generator was continued with the new unit. Immediately preceding and following the exchange of tubes, measurements of intensities and half value layers were made in air by means of a Fricke-Glasser dosimeter. The results are recorded in Table I (see below).

The intensity of x-rays from the shock-proof unit is from 40 to 50 per cent higher than the radiation intensity of the Universal type tube when all other factors are identical. Half value layers without filter are approximately equal.

Dermatological results in the past year and a half with the shock-proof unit are similar to the previous clinical results with the Universal tube. Epilation and threshold skin erythema of approximately equal duration and degree are produced by equal doses in roentgens. Depth intensities were not measured.

## CARCINOMA OF THE PANCREAS

By HYMAN S. ABRAMS, M.D., *Tuscaloosa, Alabama*

Roentgenologic diagnosis of pancreatic tumor is less favorable, especially in early stages, than of similar lesions in other structures and organs. Much information is, however, possible by thorough investigation. A typical picture pathognomonic of pancreatic tumor does not exist. The signs are chiefly indirect and consist of deformities and defects of surrounding organs. These include increase in the dimensions of the normal curve formed by the second portion of the duodenum, dilatation of the stomach or duodenum, temporary or permanent defects in the stomach or duodenum, and displacement of the stomach and transverse colon in some cases. Attention should be given to the presence of relative fixation of the hepatic flexure or gall bladder. A fixed position of the former has also been observed in carcinoma of the gall bladder and may constitute the only roentgen evidence of disease in this region of the abdomen, especially if the examination is limited.

There is likewise no clinical syndrome characteristic of carcinoma of the pancreas and tests of pancreatic function are very often of no diagnostic value. The symptoms may vary from those of psychoneurosis, vague gastro-intestinal dysfunction with or without jaundice, to those of peptic ulcer or gall-bladder disease. Even in advanced stages, there may be nothing more than a general decline in health.

The size of the pancreas as seen at operation or that of a palpable mass is not always evidence of the true extent of the pathologic changes. It is, therefore, very important to consider the possible presence of this lesion even in those instances in which it is least suspected. The foregoing statements are well exemplified by two cases encountered recently.

The first is that of a white male 44 years of age, who complained of generalized muscle

TABLE I *See Nurnberger, above*  
(70 kv. peak; 10 ma.: mechanical rectification: large focus)

Filter	Universal Tube			Shock-proof Unit		
	S.T.D.	r/min.	Half value layer <sup>1</sup>	S.T.D.	r/min.	Half value layer <sup>1</sup>
0	25 cm.	203	0.58 mm. Al	21 cm.	205	0.62 mm. Al
1 mm. Al	25 cm.	60		21 cm.	84	
2 mm. Al	25 cm.	32		21 cm.	50	

<sup>1</sup> Half value layers were read from absorption curves in aluminum.



pain, most marked in the calf muscles, for about six or seven years. His chief complaints, however, were daily afternoon rise

after administration of the opaque, a collection of barium about 1.5 cm. in diameter was noted in the region of the second portion of the



Fig. 1.



Fig. 2.

Fig. 1. Demonstrates increased gastric peristalsis and dilatation of the second portion of the duodenum.

Fig. 2. Roentgenogram, taken two hours after ingestion of the opaque meal, shows the transient pseudo-diverticulum in the region of the second portion of the duodenum close to the pylorus.

in temperature followed by profuse perspiration and a loss of 14 pounds in weight in six weeks. About four months after onset of illness he complained of almost continuous dull, general, abdominal pain, vomiting, poor appetite, constipation, weakness, extreme nervousness, and insomnia. He was noted to be melancholy, became upset easily, and developed a state of anxiety.

Physical examination revealed a poorly developed and undernourished individual. There was slight tenderness on deep palpation over the abdomen. He had slight fever, mild tachycardia, and chronic bilateral catarrhal otitis media. Results of routine and special laboratory examinations were negative except for a persistent leukocytosis which averaged 17,000.

Roentgenological study of the gastro-intestinal tract revealed moderately active gastric peristalsis, delayed passage of the opaque into the duodenum, and moderate gastric residue at five hours. The second portion of the duodenum was slightly dilated (Fig. 1). Relative fixation of the hepatic flexure of the colon was noted. Because of these findings, a modified fractional study was done. Two hours

duodenum and close to the pylorus (Fig. 2). This was believed to be a pseudo-diverticulum and not to be confused with the usual type of pouching, at times encountered in this area. The possibility of carcinoma of the pancreas was suggested. Operation was not believed advisable because of the poor condition of the patient. The total white blood cell count became 24,900 and a severe secondary anemia developed. He became weaker and expired about eleven months following onset of illness.

Necropsy revealed that the head of the pancreas was slightly firmer than the remainder. There was a firm, round mass about 3.5 cm. in diameter with slight irregular contour adherent to the under surface of the distal portion of the second part of the duodenum. This duodenal segment looped over the mass mesially. Cut surface showed solid tissue believed to be carcinoma. The histologic diagnosis was adenocarcinoma of the pancreas with metastases. Metastatic lesions were noted in the liver, spleen, duodenum, kidneys, myocardium, and in a lymph node.

Several aspects of this case make it noteworthy. The clinical features, especially at

the beginning, were rather vague. The importance of psychoneurotic tendencies is not to be underestimated. The existence of

Roentgen study of the gastro-intestinal tract revealed slight cardiospasm. A large mass with fairly regular, semilunar-shaped upper

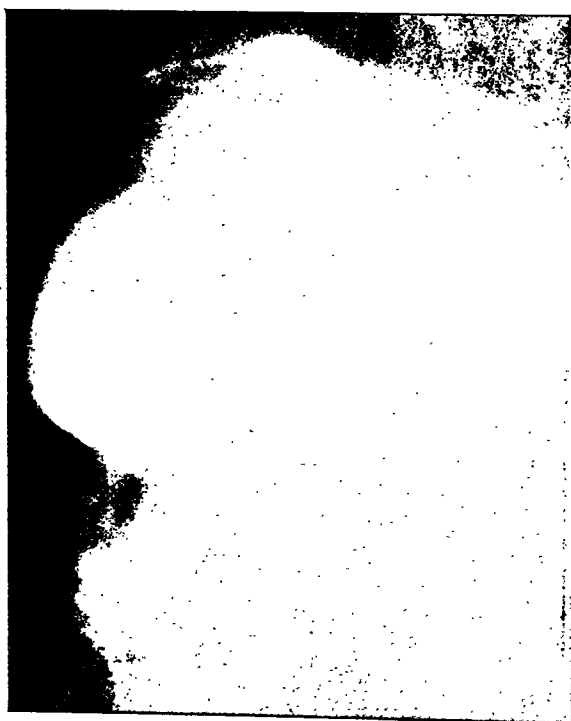


Fig. 3.

Fig. 3. Shows the large mass with fairly regular, semilunar-shaped upper surface and displacement of the stomach.

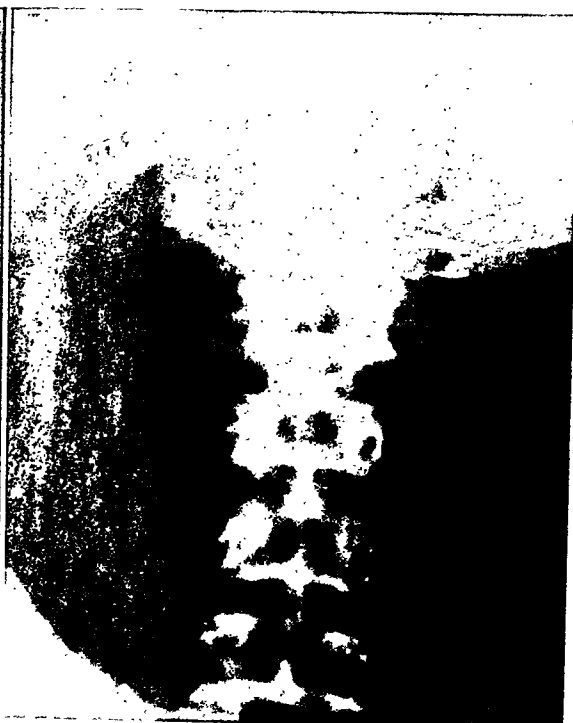


Fig. 4.

Fig. 4. Demonstrates widening of the rugæ and defects in the cardia and pars media of the stomach.

metastases with apparently slight gross involvement of the pancreas, as seen in this case, is of much importance. A pseudo-diverticulum, perhaps better termed a *transient* pseudo-diverticulum—may give evidence of the existence of pathologic changes in the region of the head of the pancreas.

The second patient was a white male, 47 years of age, who complained of a cramping pain in the left lower abdomen which radiated to the back. His appetite was poor, and he had lost about 30 pounds in weight in the past month. He stated that two weeks ago he had severe cramping in the lower abdomen and nausea following a heavy meal.

Physical examination revealed a well developed individual weighing 156 pounds (71.8 kg.). There was abdominal tenderness and a questionable tumor mass was palpated.

Laboratory examinations were negative except that gastric analysis revealed red and white blood cells, marked excess of mucus, a total acidity of 14, and no free hydrochloric acid.

surface was noted in the region of the cardia and pars media of the stomach. It was visible through the magenblase and displaced the stomach forward and to the left (Fig. 3). The stomach tube glided over the shadow of the mass. There was, however, no obstruction. The gastric rugæ appeared widened and there were defects in the region of the cardia and pars media (Fig. 4). Although some of this was apparently due to pressure by the mass, it was believed from roentgen examination that there was infiltration of the stomach. The stomach was fairly mobile and there was no localized gastric tenderness. Increase in the normal curvature of the second portion of the duodenum was noted.

Operation revealed a large, firm, nodular mass in the tail and body of the pancreas. This was separated easily from the stomach. The liver contained a few nodules. The examination was otherwise essentially negative. The diagnosis was carcinoma of the tail and body of the pancreas, with metastasis to the liver.

The post-operative course was stormy, and the patient expired on the third post-operative day, apparently as a result of pulmonary embolism. Examination of a piece of tissue removed at operation revealed fat and chronic inflammation.

#### SUMMARY AND CONCLUSIONS

1. Two cases of carcinoma of the pancreas are reported.
2. The importance of psychoneurotic tendencies is not to be underestimated.
3. Much information is often possible by thorough roentgen examination. Fractional study may often add findings not discovered in the routine examination of the gastrointestinal tract.
4. Transient pseudo-diverticula may give evidence of the existence of a lesion in the region of the head of the pancreas.
5. The size and gross appearance of the pancreas is not always indicative of the true extent of the pathologic changes. Metastasis to the myocardium occurred in one of the cases reported.

#### CULTIVATION AND CLINICAL APPLICATION OF *ALOE VERA* LEAF

By ARCHIE FINE, M.D., and SAMUEL BROWN, M.D., Cincinnati, Ohio

From the Tumor Clinic and the Department of Roentgenology, respectively, Jewish Hospital

Recent reports in the literature by Collins and Collins (1) and Wright (2) advocate the use of *Aloe vera* leaf in the treatment of radiation injuries. Our experience, though rather limited, leads us to concur in the opinions expressed by these writers. However, we have found that supplies of the leaf at times are difficult to procure, and in the case of indigent patients, to be so expensive as to limit or forbid its use. We decided to investigate the possibility of cultivating the plant so as to have an abundant and cheap source always at hand.

*Aloe vera* is a member of the family of *Liliaceae*, with a large number of representatives which are difficult to differentiate. It is a tropical or semitropical plant, native to northern Africa and southeastern Europe, and is much esteemed for its curative properties. We had considerable difficulty in obtaining a plant, for, although many florists offered us samples, none was the variety desired. It is suggested that before purchase, the plant be identified by a qualified botanist. We finally were able to obtain a specimen from the city conservatory.

The leaves are pale yellowish-green, flecked with white spots, with small thorns at the borders, the green becoming darker as the leaves

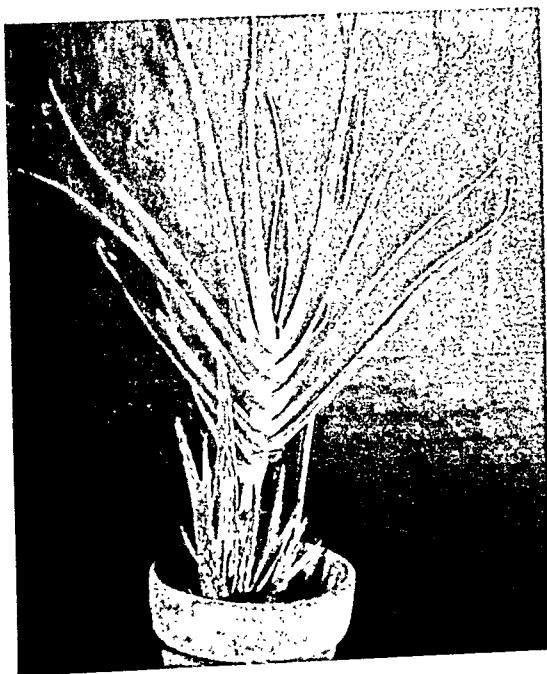


Fig. 1. *Aloe vera* plant. Note the small plants growing from suckers at the base.

become older. New plants develop by suckers from the roots. While the plant can be cultivated in one's home, it is our impression that a greenhouse, in which the temperature is more equable and the humidity fairly constant, is preferable. The plants require little attention, and too much water should be avoided. The soil preferably should be porous; a coarse sandy loam to which some manure has been added seems to be adequate. New plants can be procured quickly by leaving the original plant undisturbed in a small pot, as this tends to hasten the production of suckers. The latter, when large enough, are separated from the original plant and replanted. Leaves are cut away with a sharp knife close to the stem. The leaves keep fairly well if covered with wax paper and kept in a cool atmosphere not below 50 or above 70 degrees.

The method of clinical application has been amply described by others, but for the sake of completeness, it will be described here briefly. The leaf is cut to the size and shape of the lesion. The flat outer covering is trimmed away with a sharp knife, exposing the transparent greenish-yellow pulp which is crisscrossed by several knife cuts so as to cause the leaf to "bleed." The jelly gradually dries out or is absorbed, and at this time is replaced by a fresh leaf. Another method is to scrape the

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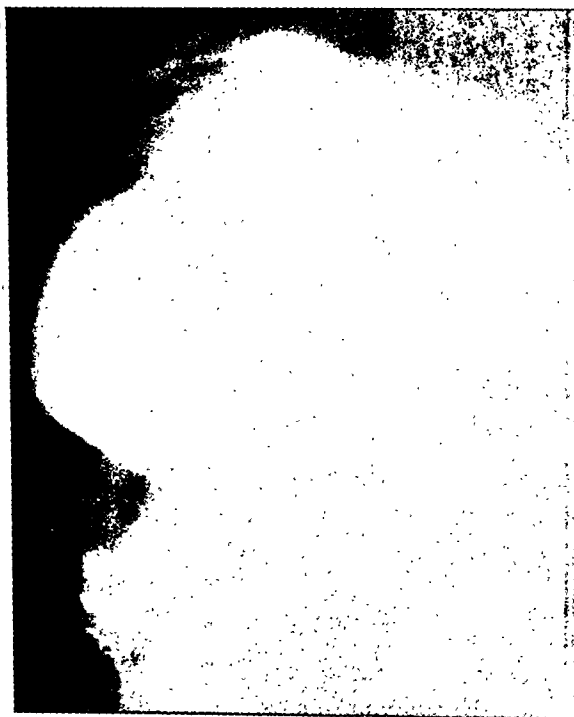


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## HOSPITAL-PHYSICIAN RELATIONS IN ENGLAND

Precedents established in what many Americans still refer to affectionately as the "Mother Country" have frequently determined decisions applied to contingencies which arise in America many years after they have appeared in England. Historians can point to scores of developments in social and economic growth to illustrate the fact. A conspicuous instance is the enactment of so-called "social" legislation and labor laws which saw their beginning in the British "New Deal" more than twenty years before they became a subject for political debate in America.

While all such precedents cannot be said to have resulted to the advantage of America, it must be obvious that the Britisher and the American are of a common ilk, and the British Isles have proven a convenient testing ground for many principles in political economy and sociology subsequently adopted or rejected in the United States.

There is currently considerable confusion in medical and hospital circles concerning the relationships between hospitals and physicians in the delivery of medical services under the American system of medical practice. There is a strong and mutual desire to achieve a solution that will protect the hospital, guarantee proper care to the patient, and assure the unshackled progress of medical science and practice.

Does England, in her more mature age, provide any aids toward solution? A recent Statement of Policy adopted by the British Medical Association may well offer valuable help to American hospitals and medical men in their efforts to find mutually desirable principles for the practice of medicine in hospitals. The policy of the British Medical Association will be of peculiar interest to the radiologist. As the American hospital gradually extends its functions into the practice of medicine, it is his specialty that has felt the first untoward effects of such a trend. How has the problem of radiologic practice in the hospital been solved in England? Do hospitals in England engage in the practice of radiology, or do radiologists there carry on a private practice in the hospital as do other medical specialists?

Many of the questions that have engendered heated debate between hospital superintendents and practitioners of the diagnostic specialties are conclusively answered in an interesting little booklet containing the policy of the British Medical Association. The whole question of physician-hospital relations is covered in the statement which is apparently a binding regulation upon British hospitals.

As in America, there are two kinds of hospitals in England—private and governmental. The private hospitals are voluntary general hospitals, like ours, while the governmental institutions include both charity hospitals maintained by local governments and special sanatoria. The Statement of Policy adopted by the British Medical Association is meant to define the respective domains of these two types of institutions and to determine the arrangements under which physicians shall practise their profession in each.

In the beginning the Statement recognizes that care of the poor shall be rendered in "Council Hospitals" corresponding to our county and city charity institutions. It is recommended that the staffs in these institutions be paid on a full or part time basis by the hospitals from funds derived from tax sources or insurance funds. Every patient admitted to these hospitals is expected to pay something toward his care if his pecuniary status permits. Membership in "contributory" or insurance plans entitling the wage earner to hospital care in the Council hospitals is restricted to those of very low income. Physicians working in the hospital are to be remunerated by the hospital either by fixed salary or by payment for definite services and responsibility. The Statement recommends the creation of a "central clearing bureau" for the admission of charity patients to the Council hospitals in each community.

"Voluntary hospitals," says the Statement, "have become increasingly the hospitals of the worker and his dependents." That class which composes the bulk of private practice in this country is customarily hospitalized in private nursing homes where physicians appointed to the visiting staff carry on their practice precisely as they do in office consultation. The

Council and Voluntary hospitals serve much the same type of patients and for this reason the British Medical Association recommends the extension of "contributory schemes" for the payment of hospital expense for these low income patients. Likewise it is recommended that, in view of the great charity load placed upon the staffs of Voluntary hospitals, physicians be remunerated for their part time services.

On this subject the Statement says, "It is certain that local authorities must continue in their council hospitals some system of paid medical staffs, whether whole or part time. If the voluntary hospital system is to persist and even more if demands for expansion are to be met, the visiting staffs must be paid on a like basis. Every extension of hospital service diminishes the field of private practice open to consultants and specialists, and economically it is no longer possible largely to increase the numbers of these practitioners without making definite provision for reasonable remuneration for their hospital work."

The British Medical Association permits no ambiguity in its use of the terms "hospital care" and "medical care." "Medical treatment," according to its official document, "includes any and all of those services which can be and are rendered by a registered medical practitioner, e.g., examination whether clinical or laboratory. . . ." There is thus no opportunity to regard radiology, pathology, etc., as a part of hospital care instead of medical care.

In the case of private patients above the income scale admitting them to membership in the contributory schemes, physicians rendering services under the above definition are to be paid on a fee-for-service basis by the patient. Out-patient Departments in the hospital are to be closed to all except charity patients and those who can pay, either privately or from insurance plans, shall have consultations or specialist services provided by the private practitioner in his office or the home.

Hospital insurance schemes should not, in the opinion of the British Medical Association, be conducted by the hospitals themselves on a service contract basis as they are in this country, but should be organized by committees entirely independent of the hospital. Payments to the hospital for hospital care should be on a cash basis and no insurance risk should be carried by the hospital.

The inclusion of any kind of medical care, which, under the definition quoted above,

would include radiology and pathology, in hospital insurance plans is definitely disapproved by the Statement of Policy. "The method of remuneration for medical services to be payment for work done, on the terms customary for such patients in each area," it says.

That section of the Statement of Policy pertaining to the practice of radiology in hospitals is of such exceptional interest that the pertinent portions of it are reprinted herewith in full:

"2. A hospital should require payment of fees from patients attending for radiological services, except from those who are members of a contributory scheme which provides such services or from those who come within the category of 'Free Patients.' *An agreed share of such fees, or an agreed honorarium, should be placed at the disposal of the medical staff and the radiological department should not be managed in such a way as to make a profit for the hospital by the exploitation of the professional services of the visiting radiologists.*

"3. A hospital may on the advice of the visiting radiologist arrange a schedule of modified charges for radiological services for patients within the scale of income limits, and based upon an average of one-half the fees commonly charged for similar private work in the district; but the schedule so arranged should not be published or exhibited publicly.

"4. A hospital situated in a district where there are qualified medical practitioners carrying on in private the practice of radiology should not provide for any patient able to pay private fees radiological services, except such as in the best interests of the patient can only be obtained in that institution.

"5. A hospital in a district where there is no other radiologist than the radiologist to the hospital may allow this officer to receive, directly from private practitioners, private patients who shall pay fees not less than those charged in private for similar cases in similar districts, and the radiologist should receive not less than two-thirds of the fees so paid, provided always that all costs incurred by the hospital be covered.

"6. Radiological services for statutory authorities (e.g., Ministry of Health, National Health Insurance, Municipal Bodies, etc.) should ordinarily be arranged to be supplied in private by private practitioners. Where such arrangements must be made with a hospital, the fees payable for the service shall be upon a scale approved by the Association. The radiologist's report shall be given in every case.

Of the fee paid not less than two-thirds should go to the radiologist for his opinion, and the remainder to the hospital to cover costs.

"9. The hospital almoner or other proper officer should certify the suitability of patients for admission and should assess and collect all payments from patients, *but the right should be reserved to the visiting radiologist to receive direct the fees for medical services to private patients.*

"10. *Fees for services to patients in pay beds should be paid to the visiting radiologist in each individual case according to the service rendered, less an agreed proportion to the hospital to meet costs.*"

This is encouraging news from abroad. With a subsidence of the acrimony that has unfortunately characterized many of the debates on hospital-physician relations in the past, there is every reason to hope for a sound and satisfactory solution to the problems surrounding the practice of radiology in American hospitals.

The American Hospital Association indicated a willingness to be guided by the principles of organized medicine in making contemporary adjustments, when it adopted a resolution at its recent annual meeting, stating that it was prepared to approve "periodic payment plans for hospital care and medical service in hospitals which are also approved by the local medical profession." What constitutes medical care and what constitutes hospital care is a question to be determined "by hospitals and the local profession."

Continued co-operation and friendly conference between organized hospitals and organized radiologists should produce a solution in this country as it has in England, acceptable both to hospitals and medical men.

MAC F. CAHAL  
*Executive Secretary*

540 North Michigan Avenue  
Chicago, Illinois

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# RADIOLOGICAL SOCIETIES IN THE UNITED STATES

*Editor's Note.*—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—*Chairman*, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary*, Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

*Los Angeles County Medical Association, Radiological Section.*—*President*, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president*, E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary*, Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer*, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

*Pacific Roentgen Club.*—*Chairman*, Lyell C. Kinney, M.D., San Diego; *Secretary*, L. Henry Garland, M.D., 450 Sutter Street, San Francisco. Executive Committee meets quarterly; Club meets annually during annual session of the California Medical Association.

*San Francisco Radiological Society.*—*Secretary*, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

## COLORADO

*Denver Radiological Club.*—*President*, F. B. Stephenson, 452 Metropolitan Bldg.; *Vice-president*, K. D. A. Allen, M.D., 452 Metropolitan Bldg.; *Secretary*, E. A. Schmidt, M.D., 4200 E. Ninth Ave.; *Treasurer*, H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—*Chairman*, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Secretary-Treasurer*, Max Clinman, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

## DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

## FLORIDA

*Florida Radiological Society.*—*President*, H. O. Brown, M.D., 404 First National Bank Bldg., Tampa;

*Vice-president*, H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer*, J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

## GEORGIA

*Georgia Radiological Society.*—*President*, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president*, William F. Lake, M.D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer*, Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

## ILLINOIS

*Chicago Roentgen Society.*—*President*, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president*, Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer*, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

*Illinois Radiological Society.*—*President*, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president*, Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer*, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—The next meeting will be May 2, 3, 4, 1939, to be held in Rockford. The officers of the Section for the coming meeting are Harry B. Magee, M.D., of Peoria, *Chairman*, and Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago, *Secretary*.

## INDIANA

*Indiana Roentgen Society.*—*President*, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect*, Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president*, A. C. Holley, M.D., Attica; *Secretary-Treasurer*, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## MAINE

See New England Roentgen Ray Society.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—*Chairman*, Whitmer B. Firor, M.D., 1100 N. Charles St.; *Secretary*, Walter L. Kilby, M.D., 101 W. Read St. Meetings third Tuesday of each month.

## MASSACHUSETTS

See New England Roentgen Ray Society.

## MICHIGAN

*Detroit X-ray and Radium Society.*—*President*, Sam W. Donaldson, M.D., 326 N. Ingalls St., Ann Arbor;



*Vice-president*, Clarence Hufford, M.D., 421 Michigan Ave., Toledo, Ohio; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave.

*Michigan Association of Roentgenologists*.—*President*, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

#### MINNESOTA

*Minnesota Radiological Society*.—*President*, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

#### MISSOURI

*The Kansas City Radiological Society*.—*President*, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists*.—*President*, Paul C. Schnoebelen, M.D.; *Secretary*, W. K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

#### NEBRASKA

*Nebraska Radiological Society*.—*President*, T. T. Harris, M.D., Clarkson Memorial Hospital, Omaha; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

#### NEW HAMPSHIRE

See New England Roentgen Ray Society.

#### NEW JERSEY

*Radiological Society of New Jersey*.—*President*, Milton Friedman, M.D., 31 Lincoln Park, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

#### NEW YORK

*Brooklyn Roentgen Ray Society*.—*President*, Albert Voltz, M.D., 115-120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island

College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

*Buffalo Radiological Society*.—*President*, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen-ray Society*.—*President*, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

*Long Island Radiological Society*.—*President*, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society*.—*President*, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

*Rochester Roentgen-ray Society*.—*Chairman*, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

*Associated Radiologists of New York, Inc.*—*President*, Albert L. Voltz, M.D., 115-120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. J. Francis, M.D., 121 Madison Ave., New York City; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

#### NORTH CAROLINA

*Radiological Society of North Carolina*.—*President*, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

Since all these vagaries are incidental in the presence of a malignancy, the medical profession should insist that, at least, a lateral roentgenogram of the head, a postero-anterior roentgenogram of the chest, and a roentgenogram of the pelvis be taken routinely before any major operative procedure, regardless of age and regardless of whether or not a malignancy is present. It has been found that metastatic processes may exist; also, by the nature of their distribution, location, and density a

proper inference can be made as to their probable origin; whether lymphangitic or hematogenous in distribution; whether osteoplastic or osteoclastic in nature. Their presence should influence the kind and degree of therapeutic intervention, for it is our obligation to guard the welfare and best interests of the patient and avoid undesirable or unnecessary procedures.

M. J. HUBENY, M.D.

## ANNOUNCEMENTS

### THE AMERICAN BOARD OF RADIOLOGY

The next examination to be conducted by The American Board of Radiology will be in St. Louis, May 11 to 14, 1939. Those contemplating appearing for examination at that

time should file their applications with the Secretary by February 1, if possible.

A new Registry of the Diplomates of The American Board of Radiology will be published early in 1939. Any changes of address since the publication of the last Registry should be sent immediately to the Secretary's office.

Following is a list of those who have been certified during 1938:

Name	Address	Field
1. Anderson, William K.	Saginaw, Mich.	Roentgenology
2. Apple, Elbert D.	Greensboro, N. C.	Radiology
3. Ashbury, Howard H.	Elkins, West Va.	Therapeutic Radiology
4. Athle, Laxman H.	Bombay, India	Roentgenology
5. Baird, Lester W.	Temple, Tex.	Radiology
6. Barden, Robert P.	Pittsburgh, Pa.	Radiology
7. Barker, Hiram O.	Alexandria, La.	Roentgenology
8. Belair, Joseph F.	Washington, D. C.	Roentgenology
9. Bell, Dorothy	New York, N. Y.	Therapeutic Radiology
10. Bell, J. Sheridan	New York, N. Y.	Radiology
11. Benninghoven, Carl D.	San Mateo, Cal.	Roentgenology
12. Bogart, Franklin B.	Chattanooga, Tenn.	Radiology
13. Borrelli, Frank J.	New York, N. Y.	Radiology
14. Bowen, Albert	Fort Sam Houston, Tex.	Roentgenology
15. Briggs, Rowland S.	San Francisco, Cal.	Radiology
16. Brooks, Edward C.	Montreal, Canada	Diagnostic Roentgenology
17. Bullitt, James B.	San Jose, Cal.	Radiology
18. Butler, Frank E.	Portland, Ore.	Roentgenology
19. Connelly, Marie L.	Chicago, Ill.	Roentgenology
20. Cotton, Albertus	Baltimore, Md.	Diagnostic Roentgenology
21. Curtis, Richard C.	Corsicana, Tex.	Roentgenology
22. Dirkse, Paul	Peoria, Ill.	Radiology
23. Disbrow, G. Ward	Summit, N. J.	Diagnostic Roentgenology
24. Dobbs, William G. H.	New Haven, Conn.	Radiology
25. Dwyer, Maurice F.	Seattle, Wash.	Radiology
26. Earl, David M.	Iowa City, Ia.	Radiology
27. Epstein, Bernard S.	Brooklyn, N. Y.	Diagnostic Roentgenology
28. Ettinger, Arthur	New York, N. Y.	Diagnostic Roentgenology
29. Farber, George J.	Baltimore, Md.	Radiology
30. Fierstein, Jacob	New York, N. Y.	Diagnostic Roentgenology
31. Fine, Archie	Cincinnati, O.	Radiology
32. Foley, Sydney I.	Flint, Mich.	Radiology
33. Ford, Glenn R.	Endicott, N. Y.	Roentgenology
34. Golan, Myer E.	New York, N. Y.	Radiology
35. Goldberg, Henry	New York, N. Y.	Therapeutic Radiology
36. Gonzalez-Martinez, Isaac F.	San Juan, P. R.	Radiology
37. Gray, Earl H.	Woodland, Cal.	Radiology
38. Grinnan, Andrew G.	New York, N. Y.	Diagnostic Roentgenology
39. Hagelschaw, Gayland L.	Bay City, Mich.	Roentgenology
40. Hankins, Franklyn D.	Riverside, Cal.	Therapeutic Radiology
41. Harrington, Elmer J.	Holyoke, Mass.	Diagnostic Roentgenology
42. Hartgraves, Thomas A.	Phoenix, Ariz.	Radiology

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|------|------------------------|-----------------------|--------------------------|
| 43.  | Harvey, Joseph L.      | Waterbury, Conn.      | Radiology                |
| 44.  | Henderson, Orville L.  | New York, N. Y.       | Radiology                |
| 45.  | Henle, Carye-Belle     | Newark, N. J.         | Radiology                |
| 46.  | Hirsch, Henry          | New York, N. Y.       | Roentgenology            |
| 47.  | Horvath, Rudolph J.    | New York, N. Y.       | Diagnostic Roentgenology |
| 48.  | Ingersoll, Charles F.  | Grand Rapids, Mich.   | Radiology                |
| 49.  | Inlow, Herbert H.      | Shelbyville, Ind.     | Radiology                |
| 50.  | Irvine, Archie D.      | Edmonton, Alberta     | Radiology                |
| 51.  | Jackson, Howard L.     | Springfield, Mass.    | Diagnostic Roentgenology |
| 52.  | Jellen, Joseph         | Los Angeles, Cal.     | Radiology                |
| 53.  | Jellinger, David L.    | New York, N. Y.       | Radiology                |
| 54.  | Kalayjian, Bernard S.  | Charleston, S. C.     | Radiology                |
| 55.  | Karshner, Rolla G.     | Los Angeles, Cal.     | Roentgenology            |
| 56.  | Kile, Robert F.        | San Francisco, Cal.   | Radiology                |
| 57.  | Klein, Isadore         | New York, N. Y.       | Diagnostic Roentgenology |
| 58.  | Knox, Lawrence M.      | Carmel, Cal.          | Roentgenology            |
| 59.  | Koenig, Carl F.        | Philadelphia, Pa.     | Radiology                |
| 60.  | Laing, Donald R.       | Pasadena, Cal.        | Radiology                |
| 61.  | Lattomus, Winfield W.  | Wilmington, Del.      | Diagnostic Roentgenology |
| 62.  | Lavine, Morris J.      | Syracuse, N. Y.       | Diagnostic Roentgenology |
| 63.  | Leclercq, George T.    | Minneapolis, Minn.    | Roentgenology            |
| 64.  | Lefrak, Louis          | New York, N. Y.       | Diagnostic Roentgenology |
| 65.  | Leibert, Harry F.      | Bethlehem, Pa.        | Radiology                |
| 66.  | Levene, George         | Boston, Mass.         | Radiology                |
| 67.  | Levi, Leo M.           | Pasadena, Cal.        | Therapeutic Radiology    |
| 68.  | Levinson, Louis J.     | Newark, N. J.         | Therapeutic Radiology    |
| 69.  | Lipscomb, Thomas H.    | Jacksonville, Fla.    | Roentgenology            |
| 70.  | Lofstrom, James E.     | Detroit, Mich.        | Radiology                |
| 71.  | Lutze, Frederick H.    | Brooklyn, N. Y.       | Radiology                |
| 72.  | MacRae, J. Donald      | Asheville, N. C.      | Roentgenology            |
| 73.  | McCarty, E. D.         | Seattle, Wash.        | Radiology                |
| 74.  | McNeill, Clyde         | Louisville, Ky.       | Roentgenology            |
| 75.  | Macdonald, Ian G.      | Cornwall, N. Y.       | Therapeutic Radiology    |
| 76.  | McAvin, James S.       | Omaha, Nebr.          | Radiology                |
| 77.  | Madden, John E.        | Philipsburg, Pa.      | Roentgenology            |
| 78.  | Marshall, William A.   | Chicago, Ill.         | Radiology                |
| 79.  | Martin, James L.       | Washington, D. C.     | Radiology                |
| 80.  | Maurer, John F.        | Somerset, Pa.         | Roentgenology            |
| 81.  | Mayoral, Antonio       | New Orleans, La.      | Diagnostic Roentgenology |
| 82.  | Meister, Edward J.     | Denver, Colo.         | Radiology                |
| 83.  | Meltsner, Louis        | Hoboken, N. J.        | Diagnostic Roentgenology |
| 84.  | Mengel, Charles L.     | Allentown, Pa.        | Therapeutic Radiology    |
| 85.  | Merrill, Adelbert S.   | Manchester, N. H.     | Roentgenology            |
| 86.  | Milholland, William G. | Fresno, Cal.          | Radiology                |
| 87.  | Moore, Frank T.        | Akron, O.             | Radiology                |
| 88.  | Muller, Frederick W.   | San Diego, Cal.       | Roentgenology            |
| 89.  | Murphy, Walter T.      | Buffalo, N. Y.        | Radiology                |
| 90.  | Noll, Joseph E.        | Port Jervis, N. Y.    | Diagnostic Roentgenology |
| 91.  | O'Donoghue, James      | St. Joseph, Mo.       | Radiology                |
| 92.  | Okrainetz, Clara L.    | New York, N. Y.       | Radiology                |
| 93.  | Olpp, John L.          | Englewood, N. J.      | Radiology                |
| 94.  | Parrish, Madison E.    | Sumter, S. C.         | Radiology                |
| 95.  | Peterson, Harold O.    | Minneapolis, Minn.    | Radiology                |
| 96.  | Pitts, Thomas A.       | Columbia, S. C.       | Radiology                |
| 97.  | Pohle, Ernst A.        | Madison, Wis.         | Radiology                |
| 98.  | Pomeroy, Lawrence A.   | Cleveland, O.         | Therapeutic Radiology    |
| 99.  | Ponemon, Irving W.     | Jamaica, L. I., N. Y. | Roentgenology            |
| 100. | Quimby, Will A.        | Wheeling, West Va.    | Radiology                |
| 101. | Rayle, Albert A.       | Atlanta, Ga.          | Roentgenology            |
| 102. | Rich, James S.         | Evansville, Ind.      | Roentgenology            |
| 103. | Robinson, J. Maurice   | San Francisco, Cal.   | Radiology                |
| 104. | Root, Joseph C.        | Cleveland, O.         | Diagnostic Roentgenology |
| 105. | Runkle, William A.     | Memphis, Tenn.        | Diagnostic Roentgenology |
| 106. | Sammert, Joel F.       | Hines, Ill.           | Radiology                |
| 107. | Sampson, David A.      | Philadelphia, Pa.     | Radiology                |
| 108. | Schecter, Samuel       | New York, N. Y.       | Diagnostic Roentgenology |
| 109. | Schenk, Max            | New York, N. Y.       | Radiology                |
| 110. | Schmidt, William H.    | Philadelphia, Pa.     | Radiology                |
| 111. | Schraer, Paul H.       | Philadelphia, Pa.     | Radiology                |
| 112. | Schumacher, Arthur H.  | Cleveland, O.         | Roentgenology            |
| 113. | Shumaker, Paul R.      | Oakland, Cal.         | Roentgenology            |
| 114. | Simonds, Francis L.    | Omaha, Nebr.          | Radiology                |
| 115. | Smith, Charles D.      | Richmond, Va.         | Radiology                |
| 116. | Smith, Ivan H.         | London, Ont.          | Therapeutic Radiology    |
| 117. | Stark, Jesse D.        | New York, N. Y.       | Diagnostic Roentgenology |
| 118. | Stein, Joseph          | Hawthorne, N. Y.      | Diagnostic Roentgenology |

Dr. J. E. W. BROCHER, Geneva. A volume of 89 pages, with 101 illustrations. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 19.50.

The author has attempted in a well arranged monograph to present in brief form each of the factors which may be the cause of low back pain. Each of the possible causative factors is presented concisely and well, and, of these conditions, all that are commonly recognized to-day as causative factors in backache are presented.

Of the causative factors in lumbosacral backache a more elaborate discussion is given. The pathological, anatomical background for this is laid by Prof. Dr. M. Askanazy of the pathological institute of Geneva. The author goes on with a theoretical discussion of the causes of lumbago and sciatica, testing con-

ditions recognized as causes of the condition. This follows a discussion on the differential diagnosis which the author divides into three parts, from the standpoint of internal medicine, from the standpoint of surgery, and from the standpoint of gynecology. Under the differential diagnosis from the standpoint of surgery, mention is made of the prolapsed disk as a cause of pain.

A section of illustrative roentgenograms follows: these are beautifully reproduced and present most of the common lesions. Following this, a section of anatomical-pathological cuts is given, all of which are well selected and demonstrate well the points to be illustrated. The volume is beautifully printed and the illustrations are clear, as is usually found in this series of monographs. It is a volume well worth while to anyone interested in orthopedic surgery.

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# ABSTRACTS OF CURRENT LITERATURE

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BENJAMIN COPLEMAN, M.D., of Perth Amboy, N. J.	ANTONIO MAYORAL, M.D., of New Orleans, La.
IRVING I. COWAN, M.D., of Milwaukee, Wis.	JOHN G. MENVILLE, M.D., of New Orleans, La.
JOSEPH T. DANZER, M.D., of Oil City, Penna.	LESTER W. PAUL, M.D., of Madison, Wis.
PERCY J. DELANO, M.D., of Chicago, Ill.	ERNST A. POHLE, M.D., Ph.D., of Madison, Wis.
WILLIAM H. GILLENTINE, M.D., of New Orleans, La.	ERNST A. SCHMIDT, M.D., of Denver, Colo.
HANS W. HEFKE, M.D., of Milwaukee, Wis.	W. A. SODEMAN, M.D., of New Orleans, La.
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## ANEURYSM

Rasmussen Aneurysm: Its Roentgen Appearance. Report of Case, with Necropsy. Barnet P. Stivelman and Milton Malev. *Jour. Am. Med. Assn.*, 110, 1829-1831, May 28, 1938.

In 1868 Rasmussen reported a series of aneurysms of branches of the pulmonary artery in tuberculous cavities. These have long been recognized among the more common causes of massive and fatal hemoptysis in phthisis. Fearn described such an aneurysm about 100 years ago. Postmortem examination revealed numerous cavities in both lungs. "In the upper left lobe there was an evacuated cavity, two inches in diameter and into it was seen jutting distinctly an aneurysmal sac as large as a nutmeg, which had burst by a cleftlike opening. The parieties of the sac were thin, and it did not contain any fibrinous layers. A vessel the size of a small crow-quill, leading from a considerable trunk of the pulmonary artery, was distinctly traceable into the sac." The aneurysms result from the absence of support on one side of the vessel following the destruction of the adjacent lung tissue. The tendency of the vessel to expand toward the unsupported side was materially hastened by the increased intra-arterial pressure as a consequence of the destruction of the neighboring blood vessels by the tuberculous process.

A case is reported in which the aneurysm was clearly visible on the roentgenogram of the chest.

CHARLES G. SUTHERLAND, M.D.

## ANIMAL EXPERIMENTATION

The Behavior of the Reticulocytes of the White Mouse Following Roentgen Irradiation. H. Langendorff. *Strahlentherapie*, 1938, 62, 304.

In this third communication of a series of articles on the same subject, the author compared the effect of single doses and protracted fractional doses. The intensity was 0.5-8 r/min. for the single dose and 1 r/min. for the second method. The total doses applied varied from 100 to 1,000 r. It appeared that the effect of the fractional method without protraction was much more pronounced, both on the reticulocytes as well as on the organism as a whole than for the protracted fractional dose. The reaction following "long time" irradiation took a longer course in most instances than for the other method; likewise the same total dose was tolerated better with the protracted fractional dose than with simple fractionation.

ERNST A. POHLE, M.D., Ph.D.

## APPARATUS

Importance of Rapid Exposures in the Roentgen Physiologic Study of the First Stages of Deglutition. P. Huet and Nemours-Auguste. *Bull. et Mém. Soc. de Radiol. Méd. de France*, 26, 148-150, March, 1938.

In their study of deglutition, the authors find that rapid exposures, of less than  $\frac{1}{100}$  second, are necessary.

Such exposure times are obtained by the use of the Synchro-contactor of the Compagnie Generale de Radiologie, using 140 kv. with 50 ma. Excellent profile roentgenographs are obtained on fine-grained screens by this technic.

S. R. BEATTY, M.D.

Dispersion of Short Waves in the Neighborhood of the Emitting Apparatus. André Denier. *Bull. et mém. Soc. de Radiol. Méd. de France*, 8, 119, 120, February, 1938.

The author gives the results of his studies of the dispersion of short wave currents in the neighborhood of the apparatus. Metallic mesh screening is insufficient; a solid screen absorbs all of the radiation. The concentration of energy is greatest near the walls of the room. The approach of a piece of metal or of an individual to the recording apparatus or near to the short wave apparatus while a patient is being treated, results in a diminution of the energy. A metallic screen about the patient may offset the absorbing effect of nearby walls.

S. R. BEATTY, M.D.

The Technic of Rapid Radiographic Development. Lars Lönnerblad. *Acta Radiol.*, 19, 73-84, March, 1938.

The author describes a developer which contains pyrokatechin and caustic alkali as its chief ingredients. Due to rapid oxidation when exposed to air, development must take place in a tank with small surface and tight cover. The process must be watched continuously; for this purpose the tank walls are made of transparent glass. By this method, full development of a roentgenogram was possible within from 30 to 40 seconds.

ERNST A. SCHMIDT, M.D.

A Simple Portable Apparatus for Galvanization. T. Nogier. *Bull. et mém. Soc. de Radiol. Méd. de France*, 8, 114-116, February, 1938.

Using two to six dry batteries of 4.5 volts and three rheostats of 10,000 ohms each, the author has devised a source of direct current for galvanization free of line variations and of the inconveniences of wet cells. With two cells, up to 9 ma. with 1,000 ohms, and with six cells, up to 20 ma. are available.

S. R. BEATTY, M.D.

Theory and Practice of Direct Radiocinematography. Van de Maele. *Bruxelles-méd.*, 18, 101-106, Nov. 28, 1937.

The author discusses the advantages and disadvantages of the indirect and direct methods of roentgen cinematography. He has constructed an apparatus for direct cinematography which is briefly discussed. With

it, he has been able to secure films of the abdominal organs which he does not believe can be successfully registered by the indirect method.

S. R. BEATTY, M.D.

## ARTHRITIS

The Place of X-rays in the Treatment of Certain Forms of Chronic Arthritis. F. Hernaman-Johnson. *British Jour. Radiol.*, 10, 765-780, November, 1937.

The author summarizes as follows: "The local application of x-rays is of great value in cases of hyperthrophic, non-infective osteo-arthritis; worth trying in chronic infective arthritis, and may give local and temporary relief in rheumatoid conditions. It is valueless in true degenerative arthritis in the very old.

"The constitutional use of x-rays is of pronounced value in checking the otherwise inevitable advance of spinal arthritis in young people, and its possibilities in the treatment of rheumatoid arthritis are worth investigating."

AUTHOR.

The Arthritic Syndrome, Radiodiagnosis, and Indications for Physiotherapy. P. Robert. *Bull. et mém. Soc. de Radiol. Méd. de France*, 8, 109, 110, February, 1938.

A brief discussion of the arthritic syndrome. The author favors ionization with potassium iodide in the more accessible joints, roentgen therapy to the spine and hips.

S. R. BEATTY, M.D.

## CANCER (DIAGNOSIS)

Epithelioma of the Mouth in Hottentot Women. J. Helman. *South African Med. Jour.*, 12, 17, 18, Jan. 8, 1938.

The author describes a relatively frequent type of epithelioma of the lips and buccal mucous membrane encountered in Hottentot women who smoke a certain metal pipe made of tin, iron, or brass, and shaped like a straight cigarette-holder. After a few puffs this pipe gets very hot. Leukoplakia as a precancerous condition is frequently observed. The condition was never observed in male Hottentots, who use the ordinary wood pipe, either home-made or of European manufacture.

ERNST A. SCHMIDT, M.D.

Modern Trends in the Treatment of Cancer of the Rectum and Rectosigmoid. Fred W. Rankin. *Jour. Am. Med. Assn.*, 109, 1719-1723, Nov. 20, 1937.

In the hands of men of mature experience the widest extirpation is bound to be the choice of the radical surgical procedures. Age, co-existing debilitating diseases, and general undermining of the physical equilib-

rium demand even a wider selection of methods than is ordinarily essential in the surgical treatment of malignant growths.

The acceptance of group management with pre-operative hospitalization during the rehabilitation and decompression by medical or surgical measures is now almost universal and has proved its worth beyond any peradventure.

The diagnosis of cancer of the rectum and rectosigmoid can be made in 100 per cent of the cases, provided a careful digital examination or proctoscopic examination, or both, is made as a matter of routine. Biopsy may be done regularly or in cases in which there is a question of the pathologic diagnosis.

There are, unfortunately, no early pathognomonic symptoms. Perhaps irregularity of the bowel habit as characterized by diarrhea, or constipation, or alternating periods of the two over a short time, e.g., a month or six weeks, is the most characteristic symptom.

A growth anywhere within 25 cm. of the anal margin can always be diagnosed by proctoscopy, and direct visual examination is preferable to radiography. However, if the result of proctoscopic examination is negative, x-ray investigation is urgently indicated.

A knowledge of the type of pathologic process is important from the standpoint of both prognosis and treatment. While it is uniformly felt that the higher grade tumors are radiosensitive and less amenable to surgical treatment, it is definitely known that there are many exceptions to this rule. In order to grade the tumor, rather than as a diagnostic measure, biopsy has been made regularly on all rectal and rectosigmoidal cancers for twelve years. Any tendency to scatter cancer cells by this biopsy has not been observed in the author's experience.

It is frequently advantageous to test the radiosensitivity by an actual application. Perhaps the future will reveal radium alone or in combination with surgical treatment to have its most advantageous use in high grade growths in the young. The colloidal group of cancers, while notoriously prone to recur after surgical removal, are fairly well established as radiosensitive tumors. Unquestionably, accumulated data show conclusively that in certain cases cancer of the rectum can be cured by radium and that the number of these cases is slowly increasing. Epitheliomas of the anal canal are better treated by radium than by surgical procedures, but as one advances toward the rectosigmoid, the latter becomes the treatment of choice.

The greatest value of radium is as a palliative procedure for inoperable and recurring lesions. With its use bleeding is frequently controlled, the tumor frequently recedes enormously, and occasionally so-called inoperable tumors are rendered removable.

Pre-operative use of radium is still a most uncertain agent and more data are necessary relative to its action before it is accepted as a routine.

Careful scrutiny of series of cases in which surgical diathermy was used emphasizes not only that colostomy was necessary in one-half of the cases, but that the mortality figures approached those for patients present-



ing the less formidable variety of surgical risks who are treated by resection. The method requires special apparatus and certainly extreme care in its application.

CHARLES G. SUTHERLAND, M.D.

A New Case of Early Gastric Cancer Invisible Macroscopically. A. Gosset, René A. Gutmann, Ivan Bertrand, and Garcia Calderon. *Bull. et Mém. Soc. de Radiol. Méd. de France*, 26, 144, 145, March, 1938.

The authors present another case of carcinoma of the stomach demonstrable roentgenologically, but not apparent to palpation or inspection at operation.

Roentgenologically the lesion was small and of the "niche en plateau" type.

S. R. BEATTY, M.D.

### CANCER (THERAPY)

Short Distance Irradiation of Skin Carcinoma. Julius Wendlberger. *München. med. Wchnschr.*, 85, 478, March 31, 1938.

The author, while considering radium needles the most desirable treatment for skin cancer, for various reasons used Bode's modification of Chaoul's technic in the treatment of these lesions.

He used a F.S.D. of 7 cm., 55 kv., 4 ma., 227 r/m. The H.L.V. in Al was 1 mm., in Cu, 0.04 mm. He gave 500 r per treatment, treating daily for six days, then giving four days' rest, then daily treatments for four days, then 12 days' rest, then daily treatments for three days. The total dose thus given was 6,500 r in 29 days. He places emphasis on the fractionation, the small field size (10-15 sq. cm. or, at the most, 25 sq. cm.), the short focus-skin distance, and the long wave length radiation, most of which is absorbed in the tumor.

In 15 cases, 90 per cent primary healing occurred, and 11 (73 per cent) were completely cured. Five other cases were not included because they later left the writer's care.

L. G. JACOBS, M.D.

Effect of Radiation Therapy on Metastatic Carcinoma of Bone. Frank E. Butler and Ivan M. Woolley. *Northwest Med.*, 37, 84, March, 1938.

The value of radiation therapy in certain types of malignancy is recognized, but its result uncertain. However, many favorable and some striking results justify its trial in spite of some unfavorable experiences.

No prediction can be made, based on the morphologic classification of tumors, as quite often, in actual practice, tumors that one would expect to be radiosensitive are not so, and *vice versa*.

The authors are convinced that deep-seated malignancy cannot be stopped by one course of roentgen therapy, but find that those patients showing favorable response can be made comfortable, and the disease kept in check for a number of years.

Because of time limit the discussion will be confined to irradiation therapy of metastatic bone tumors.

Primary bone tumors do not respond as well to irradiation.

While carcinoma of the prostate metastasizes to bone much more frequently than does carcinoma of the breast, this latter type of tumor occurs so much more frequently that, in the experience of the writers, it constitutes the bulk of the metastatic bone tumors.

Given in order, the following are the bones most frequently involved: pelvic bones; upper ends of the femora; the spine, the lumbar and cervical more often than the dorsal vertebrae. The physician should bear in mind that quite often persistent nerve pain is the only symptom of which complaint is made. Malignancy, like osteomyelitis, may attack bones long before it can be detected, and very often a pathologic fracture occurs before metastasis is discovered. For this reason when a cancer patient complains of well established nerve pain, it is the practice of the writers to irradiate the bone in the area of the nerve root.

A. MAYORAL, M.D.

Irradiation in the Treatment of Carcinoma of the Uterus, with Special Reference to Corpus Carcinoma. Louis E. Phaneuf. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 855-860, June, 1938.

In the past 20 years irradiation with radium and roentgen rays has supplanted surgery in the treatment of cervical cancer. This is in contrast to the management of cancer of the uterine body, wherein surgery is still indicated. The surgical method of treatment has given five-year arrests in 60 to 70 per cent of the cases. Irradiation in corpus carcinoma is reserved for patients advanced in years, having definite contra-indications to operation. The author gives as a preliminary report the results of irradiation in 20 cases of carcinoma of the uterine body. He reports 25 per cent of the cases as five-year survivals.

IRVING I. COWAN, M.D.

The Survival of a Case of Malignant Granuloma. P. Ponthus and Quisefit. *Bull. et mém. Soc. de Radiol. Méd. de France*, 8, 121-123, February, 1938.

A case of malignant granuloma surviving seven years after the first roentgen treatment is reported. Treatments had been local in type and had kept the patient comfortable and in good health until the onset of the terminal stages.

S. R. BEATTY, M.D.

The Treatment of Metastatic Carcinoma of the Cervical Lymph Glands. I. Jovin. *Strahlentherapie*, 1938, 62, 262.

The author discusses in detail the management of patients with metastatic cervical glands. He divides his material into three groups: (1) Those with palpable glands or suspicious glands; (2) those with metastases on one side of the neck, and operable; (3) those with either inoperable or operable glands but with bilateral involvement. The treatment for all groups is either surgical or radiological. If operable, radical resection

is advocated, otherwise x-ray or radium therapy. Technic for roentgen rays: two fields on each side of the neck which include the submental and submaxillary area as well as the parotid and supraclavicular regions. Total dose is 2,000 r applied according to Coutard's technic. Prophylactic treatment in patients without palpable glands can be given in smaller doses. The author uses about 1,000-1,500 r per field and treats all four areas over a period of 30 days.

Radium therapy can be given by means of seeds, needles, and small screens implanted into the tumors. However, external radium therapy seems to be the method of preference. If large amounts of radium are available, telecurietherapy is indicated; otherwise, special molds have to be prepared holding anywhere from 100 to 300 mg. radium and applied at a distance of from 3 to 8 cm. from the skin. The treatment takes approximately from 8 to 12 days, with daily exposures of from 8 to 16 hours. For a distance of 3 cm., the total dose is 400 mg.-hr. per sq. cm. of surface.

The author recommends prophylactic irradiation in all patients because, even in the absence of definitely palpable glands, there may be microscopic metastases. In Group 2, irradiation may be considered before resection. In patients with poor general condition, radiation therapy should be given preference. All patients must receive post-operative irradiation. Radium or x-ray therapy is the method of choice for Group 3.

ERNST A. POHLE, M.D., Ph.D.

The Effect of Near Distance Roentgen Irradiation on the Malignancy of Cancer Tissue. A. E. Roffo. *Strahlentherapie*, 1938, 62, 363.

The author studied the effect of near distance roentgen rays on implanted carcinoma and sarcoma in rats. Potentials of 54 and 60 kv. were used, with the doses varying from 68 to 2,660 r. Irradiation of tumor specimens *in vitro* before implantation, according to this method, decreased the malignancy of the neoplasms. The effect was more pronounced the higher the potential and the longer the duration of the exposure. The carcinoma was affected more by irradiation than the sarcoma.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy in Primary Lung Carcinoma. Armando Cabrera. *Medicina de Hoy*, 3, 7-12, January, 1938.

Four cases of primary carcinoma of the lung treated by short wave roentgen therapy, in which the patients were restored to health, are reported. The writer knows these to be exceptional cases and admits many failures. He trusts that the results will be permanent and not transitory. Coutard's technic was followed in giving the treatments.

A short abstract of each case follows.

Case A, a Cuban farmer 55 years of age. The tumor was located in the base of the right lung, with metastasis to the right humerus. The chest was treated

through four ports of entry, each receiving 2,500 r. The total dosage was given in 15 consecutive days. Additional doses were given to the arm.

Case B, a Cuban chauffeur 54 years of age. The tumor was located in the right hilum, causing atelectasis of the upper lobe. This patient received 9,000 r through three ports of entry.

Case C, a Cuban farmer 68 years of age. The tumor was located in the left upper lobe. The patient received 13,000 r through five ports of entry, in 40 treatments, over a period of seven weeks.

Case D, a Spanish merchant 64 years of age. The tumor was located in the right upper lobe. The patient received 11,000 r. Number of ports of entry not given.

The writer makes a plea to the general practice to submit early cases to roentgen therapy.

A. MAYORAL, M.D.

Correlation of Calculated Tumor Doses and Five-year Survivals in Radiation Therapy of Cancer of the Cervix: A Review of 136 Cases. E. L. Frazell. *Am. Jour. Roentgenol. and Rad. Ther.*, 39, 861-865, June, 1938.

The author reviewed primary carcinoma of the cervix. Minimum doses of radiation were calculated in terms of threshold erythemas. Seventy per cent of the cases were either advanced or very advanced as to extent of the disease in the pelvis and in these cases the calculated dose was generally low and the survival rate correspondingly poor. The author concludes that any method of radiation therapy delivering less than six erythemas to the parametrium will fail to control the disease in the majority of the cases.

IRVING I. COWAN, M.D.

## THE COCCYX

Coccygodynia and Pain in the Superior Gluteal Region and Down the Back of the Thigh: Causation by Tonic Spasm of the Levator Ani, Coccygeus and Piriformis Muscles and Relief by Massage of These Muscles. George H. Thiele. *Jour. Am. Med. Assn.*, 109, 1271-1274, Oct. 16, 1937.

When the coccyx or the coccygeal joints are injured or when the surrounding tissues are the seat of inflammation, any contraction of the muscles attached to the coccyx will excite the characteristic pain of coccygodynia. Observation has confirmed the presence of tonic spasm of the levator ani and coccygeus muscles. A large percentage of patients with coccygodynia complain also of pain in the supragluteal region and/or down the back of the thigh; tenderness and tonic spasm of the piriformis muscle is also found almost without exception.

Some of the patients stated that their pain first began as a sense of weight or heaviness which they at first referred to the rectum. This sensation gradually became more severe, and the complaint was that of severe aching and cramping pain referred to the region of the coccyx, more noticeable when sitting in a hard chair, or

during the acts of arising and sitting down. Inability to lie comfortably on the back was a frequent complaint, the pain being worse in that position. Periodic attacks of lancinating severe coccygeal pain superimposed on the aching pain were frequent.

Massage of the pelvic muscles involved by a definite technic will definitely relieve the symptoms in the great majority of cases.

CHARLES G. SUTHERLAND, M.D.

## DIABETES

Inoperable Carcinoma of the Ovary in a Diabetic Patient Cured by Roentgen Rays. F. Gál. *Strahlen-therapie*, 62, 516, 1938.

The author has seen several cases of advanced carcinoma of the uterus in patients who suffered at the same time from diabetes. He noticed that they responded remarkably well to moderate doses of roentgen rays. He relates briefly in this article the history of a woman 32 years of age with a carcinoma of the ovary, operated on in June, 1928. Only partial removal of the tumor could be carried out. Two weeks after the operation she received through two sacral and two abdominal areas 500 r per field at 180 kv., 0.5 Cu + 3 mm. Al. Further series were given several times at intervals of from six to eight weeks. The patient has been re-examined regularly and now, six years after the operation, she is in good general condition and there is no evidence of tumor. It is concluded that apparently carcinoma of the diabetic reacts more favorably to irradiation than of those with normal sugar metabolism.

ERNST A. POHLE, M.D., Ph.D.

## THE DIAPHRAGM

Roentgenologic Diagnosis of Various Juxta-diaphragmatic Lesions, Particularly Perinephric Abscess. Ralph D. Bacon. *Pennsylvania Med. Jour.*, 41, 992-1000, August, 1938.

Various types of herniations of the diaphragm, both congenital and acquired, are described briefly by the author, and are illustrated by typical cases.

Extrinsic lesions affecting the diaphragm are described in greater detail. The author states that a partially-obstructing foreign body in a bronchus will cause a depression and partial fixation of the diaphragm on the affected side, and that when the obstruction is complete the hemidiaphragm is elevated and does not move. Lower lobe pleurisy, diaphragmatic pleurisy, and lower lobe pneumonia may elevate and restrict the movement of the diaphragm but it is not affected in bronchopneumonia or other bronchogenic lesions.

Pneumoperitoneum is found in 85 per cent of all patients with a perforated ulcer who have had a relatively long ulcer history. This does not appear to be a good diagnostic sign when the ulcer symptoms are of less than two months' duration. The most frequent cause of immobilization of the diaphragm is peritonitis or a subdiaphragmatic abscess; 25 per cent of the abscesses, according to Delario, contain air.

The author describes his technic which has been used as an aid in the diagnosis of perinephric abscess. After filling the pelvis with contrast media, two exposures are made of the kidney on the same film, one in deep inspiration and one in forced expiration. There will be little or no movement of the kidney pelvis on the affected side.

JOSEPH T. DANZER, M.D.

Error of Diagnosis Due to an Anomalous Right Diaphragm. Guénaux. *Bull. et mém. Soc. de Radiol. Méd. de France*, 25, 783-785, December, 1937.

An anomaly of the diaphragm, not diagnosed, permitted an anomalously situated colon to interpose above the liver, giving the appearance of a consolidation at the base of the right lung-field. A barium enema demonstrated the true state of affairs.

S. R. BEATTY, M.D.

## DOSAGE

Experimental Investigations on the Effects of Roentgen Rays on the Suprarenal Glands in Rabbits. Rolf Bull Engelstad and Olav Torgersen. *Acta Radiol.*, 18, 671-687, October, 1937.

According to the authors, the roentgen doses necessary to produce definite changes in the suprarenal glands of rabbits show a decided parallelism with the doses required to produce skin changes.

Doses of 1,000 r or less were followed by practically no changes in either suprarenal glands or skin. After 1,500 r (applied in a single treatment) the changes were mild. Clearly demonstrable skin changes in rabbits require about 1,700 r, but considerably larger doses are necessary to produce an exudative epidermitis. The doses employed by the authors varied from 2,200 r to 2,500 r, administered at one séance. These doses resulted in marked degeneration in the cortex of the suprarenal glands, hyperemia, and occasionally inflammatory infiltration. The degenerative changes were most constant and most prominent in the *zona fasciculata* and the *zona reticularis*. No definite degeneration was demonstrable in the medullary substance. The first reaction observed was an initial hyperemia which appeared within 10 hours after irradiation and receded within from two to three days. The main degenerative reaction was observed, at the earliest, six days after irradiation. It was accompanied by hyperemia and, in some cases, by lymphocytic infiltration. These changes persisted up to six months, the longest period of observation, though they were most pronounced three months after radiation.

The authors emphasize that all conclusions are made difficult by the very great normal variations found histologically in the suprarenal glands of animals (differences in lipid distribution due to varying functional states, exogenic and endogenic complications, etc.). In general, previous observations and investigations of one of the authors (Engelstad) relative to the same subject were confirmed.

ERNST A. SCHMIDT, M.D.

Biologic Determination of the Distribution of Dose and of the Depth Dose Percentage for Normal and Extremely Hard Roentgen Rays. H. Langendorff, L. Graf, and J. Graf. *Strahlentherapie*, 62, 561, 1938.

*Drosophila* eggs were placed in canals drilled into a wax phantom and exposed to roentgen rays produced at 180–200 kv. with a half value layer in copper of 0.95–1.5 mm. and also 400 kv. with a half value layer in copper of 6 mm. Graphs are shown in the article giving the depth doses in the central ray obtained by this method. When compared with the results of ionization measurements done by L. and J. Graf, there appears to be satisfactory agreement. As the greatest advantage of the higher potential, the authors consider the quicker drop of the intensity in the first centimeters below the skin. This means that the normal tissue between skin and tumor in the depth receives less irradiation. Whether or not this advantage of 400 kv. x-radiation justifies the higher expense can be decided only after sufficient clinical experience.

ERNST A. POHLE, M.D., Ph.D.

## ENDOCRINE GLANDS

The Short Wave Treatment of the Endocrine System: the Diencephalon and the Mesencephalon. Giulio Samuels. *Archivio di Radiologia*, 13, No. 4, 338–347, 1937.

By means of two instruments, the spectro-reduction meter and the cicloscope, Samuels determines what endocrine organs are in dysfunction and to what extent. Short wave treatment, at times supplemented by endocrine preparations, gives good results, particularly in dysfunction of the pituitary.

E. T. LEDDY, M.D.

## THE ESOPHAGUS

Benign Stricture of the Esophagus Complicating Duodenal Ulcer. Edward B. Benedict and Ernest M. Daland. *New England Jour. Med.*, 218, 599–601, April 7, 1938.

This case report deals with a patient having an esophageal stricture following a posterior Polya type anastomosis for duodenal ulcer. A second operation, an entero-anastomosis, was done 12 days later. A nasal tube was passed several times. About three and one-half months later the patient was readmitted with an esophageal stricture of an inflammatory origin and relieved by bouginage.

It is believed that the stricture was due to an esophagitis but the nasal tube is absolved of any connection with the condition. Roentgenographs are presented demonstrating the stricture and the literature is reviewed.

J. B. McANENY, M.D.

The Irradiation of Esophageal Cancer. Max Lüdin. *Schweiz. med. Wchnschr.*, 68, 539, 540, May 7, 1938.

Case report of a patient with carcinoma of the upper esophagus (apparently not biopsied) who is alive and clinically cured two years after treatment solely with

x-ray (3,240 r to each of two lateral 8 × 10 cm. fields in 36 treatments, 180 kv., 4 ma., 2 mm. Cu filter, 70 cm. F.S.D., H.W.S. 1.9 mm. Cu).

L. G. JACOBS, M.D.

The Management of Pulsion Esophageal Diverticulum. Frank H. Lahey. *Jour. Am. Med. Assn.*, 109, 1414–1418, Oct. 30, 1937.

Pulsion diverticula far outnumber all other types. They occur as small, intermediate, and large pouches located, since they are the result of a bulging of esophageal mucosa through a congenital muscular defect at this point, at the esophagopharyngeal level.

Traction diverticula are most commonly situated within the pleura and at, or near, the level of the main pulmonary bronchi, since they are associated with inflammatory processes in the bronchial lymph glands located at this level.

Subdiaphragmatic intrapleural esophageal diverticula probably start as the result of a congenitally weak area in the esophageal wall and develop further into large sacs because of the accumulation of food within the sac and an intrasaccular pressure which is greater than the resistance of the wall of the sac.

A pharyngo-esophageal diverticulum is a protrusion of the mucosa and submucosa of the hypopharynx through the muscular wall of the hypopharynx. The sac lies between the pretracheal and prevertebral fascia, and its neck is surrounded by fibers of the inferior constrictor muscle, and the muscle which splits off from it obliquely to extend down the esophagus, the cricopharyngeus muscle. This muscle's relationship to the sac is of the utmost importance, since unless the constricting muscle fibers about the neck of the sac are accurately removed the sac is quite apt to recur.

The successful operative treatment of esophageal pulsion diverticulum involves the complete removal of the sac and its neck, the complete removal of the constrictor fibers from about the neck of the sac, and the protection of the patient from the development of cellulitis between the prevertebral and pretracheal fascia and extension of this infection into the mediastinum.

The author reviews his series of cases done by the two-stage method, which he prefers, and presents the end-results in 53 cases.

CHARLES G. SUTHERLAND, M.D.

## FISTULA

The Radiological Exploration of Some Unusual Fistulous Tracts. Julius Brams. *Illinois Med. Jour.*, 72, 534–536, December, 1937.

Brams has used radiological exploration of fistulous tracts after the injection of various opaque media and reports three unusual cases—a duodeno-biliary, a reno-cutaneous, and a biliary-cutaneous fistula. He stresses the frequent surprise one encounters in the source, course, and extent of apparently simple fistulous openings when studied in this way. In his experience he gained valuable information in cases of perirectal and peri-urethral tracts, in various abdominal

and fecal fistulae, in fistulous tracts originating from some bone pathology, and in exploring pilonidal cysts. He has never seen any ill effects from this procedure and knows of no contra-indications.

W. A. SODEMAN, M.D.

## THE FOOT

Comminuted Fractures of the Os Calcis. H. W. Spiers. *Jour. Am. Med. Assn.*, 110, 28-31, Jan. 1, 1938.

In the decade prior to 1930 the attitude in general toward this lesion was that such a fracture was unfortunate, that long-continued disability would follow, and that there would be, of course, a high degree of permanent disability. In the average case, if the foot was manipulated, and kept immobilized for a rather long period, in the long run a nearly painless though disabled foot was secured. However, it often took from two to four years before this result was obtained. Subastragaloid arthrodesis hastened the process somewhat.

Boehler's method of reduction definitely reduced the length of disability and gave less permanent disability than any other method in the author's experience. On the seventh or eighth day skeletal traction pins are placed through the posterior fragment of the os calcis and through the lower end of the tibia. With the knee in right-angle flexion on a Boehler frame, direct downward screw traction is applied. This is done to correct the upward displacement of the distal fragment, the fragment attached to the Achilles tendon, and to break up the impaction. It places the distal fragment in line with the proximal one and restores the so-called tuber angle. This is the angle of the plane of the subastragaloid joint and the body of the normal os calcis. It varies from 28 to 35 degrees in the normal foot and is partially, or wholly, lost in the average comminuted fracture.

Next, traction at a 45-degree angle to the tibia is applied. This is the angle of traction which makes necessary the pin fixation of the lower end of the tibia. This traction is applied to overcome the overriding of the fragments and thus restore the normal length of the os calcis. Lateral U-clamp compression with metal pressure pads designed to fit the normal lateral curves of the os calcis is then applied. The width of the normal os calcis is estimated, and compression to that width is rapidly applied and quickly released. There has been no circulatory disturbance with necrosis of the tissues as might be expected from this procedure.

Check-up roentgenograms are easily obtained, after which a plaster cast is applied incorporating the skeletal traction. Boehler's non-padded cast has been used regularly. It is split anteriorly before the patient leaves the table.

The Braun frame was used for four weeks post-operatively. Skeletal traction is removed at the end of the fourth week and a plaster boot applied. The patient gets around for about four weeks on crutches. At the end of the eighth or ninth week a calf-lifting walking cast is applied. This allows partial weight-bearing.

Full weight-bearing is not allowed until the fourteenth week. When weight-bearing is begun an accurately fitting arch support is supplied.

CHARLES G. SUTHERLAND, M.D.

Tophi of the Heels. Frederick Christopher and Stanley E. Monroe. *Jour. Am. Med. Assn.*, 110, 2149, June 25, 1938.

Gout is doubtless more prevalent than is commonly believed, yet the presence of tophi that simulate other lesions is quite rare. While tophi are found in many locations, they have a peculiar affinity for the ears. Tophi of the heels resembling pyogenic lesions are extremely uncommon.

The authors reported a case in which lesions on the heels had been opened five times under the supposition that they were of pyogenic origin.

Smears of the discharge from these lesions showed acicular crystals characteristic of sodium mono-urate. Uric acid studies of the patient's blood showed a high uric acid content. The response to treatment for gout was satisfactory.

CHARLES G. SUTHERLAND, M.D.

March Fracture. Henry W. Meyerding and George A. Pollock. *Surg., Gynec. and Obst.*, 67, 234-241, August, 1938.

March foot may be defined as a fracture of the second, third, or fourth—most commonly the second—metatarsal bones without known adequate cause. The most acceptable theory is that the fracture occurs as the result of overloading a foot already weakened functionally and anatomically. In any case of painful feet, a history of over-exercise, or prolonged and excessive weight-bearing, or of wearing of arch supports for weak feet, should, especially, in the absence of direct trauma, cause the physician to think of the condition and have roentgenologic investigation carried out. The symptoms should not be attributed to the more simple tenosynovitis. The roentgen films must be made in multiple projections and carefully studied at varying light angles since a bone, negative roentgenologically at first, has been found several weeks later, on roentgenological examination, or at operation, to be fractured. Differentiation is to be made from tenosynovitis and from osteogenic sarcoma. Swelling, superficial pain, tenderness, and local increase of temperature, with repeatedly negative roentgenograms, should definitely distinguish tenosynovitis. If doubt exists as to sarcoma, biopsy is indicated.

W. R. BROOKSHER, M.D.

## FOREIGN BODIES

Localization of Foreign Bodies by Planiscopy. Gunsett and Sichel. *Bull. et mém. Soc. Radiol. Méd. de France*, 26, 41, 42, January, 1938.

A method of utilizing the planigraph (Bocage) for roentgenoscopic localization of foreign bodies is de-

scribed. A small square of wire is fixed to the screen, superimposed on the shadow of the foreign body. If the foreign body is in the plane of the axis of rotation of the patient, the image will remain in the square, otherwise it will not. The depth can be determined by readjusting the position of the patient until the plane of rotation and that of the foreign body coincide.

S. R. BEATTY, M.D.

A Case of "Silent" Perforation of the Stomach Due to an Unsuspected Foreign Body. Woithelet. *Bull. et Mém. Soc. de Radiol. Méd. de France*, 26, 150-153, March, 1938.

A case of perforation of the antrum of the stomach by a common pin is reported. The pin was discovered in the roentgenographs of a gastro-intestinal examination and removed at laparotomy. The patient did not recall having ever swallowed the pin but had been having epigastric pain and a sensation of weight for about 12 years, culminating in a bout of severe pain and vomiting, with weight loss of 25 kgr., just previous to the examination.

S. R. BEATTY, M.D.

A Study of the Roentgenologic Localization of Foreign Bodies in the Respiratory and Digestive Tracts. M. Bermond. *Arch. di Radiol.*, 14, 5-15, January-February, 1938.

Bermond points out that the localization and removal of foreign bodies in the bronchi is generally easy. This remark refers, of course, to opaque foreign bodies. On the other hand, their localization in the abdomen may be very difficult, and is best done by a roentgenologic examination made immediately before operation. Often it is necessary to study the patient in various positions and to fix the position of the foreign body by reference to definite anatomical landmarks.

The paper is illustrated by roentgenograms of foreign bodies in the abdomen and has one colored plate of a drawing made at operation.

E. T. LEDDY, M.D.

## THE GALL BLADDER (Normal and Pathologic)

The Improvement of the Roentgenological Gallstone Diagnosis by the Examination of Biliary Sedimentation and Layer Formation. Åke Åkerlund. *Acta Radiol.*, 19, 23-43, March, 1938.

The author discusses the different films of sedimentation and stratification seen in the dye-filled gall bladder when radiography in erect position supplements the usual plates taken in recumbent position. No other technic than the usual duodenal technic is required (serial films in upright position with dosed compression). The various types of gall-bladder pathology (layer formation of bile, fundal sediment, layer of floating stones) are demonstrated in a series of excellent roentgenograms and diagrams. In addition

to the valuable information furnished in the visualization of cholelithiasis, especially in early and easily overlooked cases, this method gives new viewpoints on the function of normal and pathologic gall bladders, and may aid in the elucidation of the still rather obscure pathogenesis of gallstones. The roentgenological observations are based on the fact that not only concretions with calcium components have a greater specific gravity than bile or cholesterol concretions but also that, during the process of concentration, the contrast bile does not present a uniform degree of concentration. Pure cholesterol stones with a specific gravity equal to, or even lighter than, bile may form a horizontal, suspended, or floating layer of concretions during erect cholecystography.

It must be remembered that these phenomena can be observed only under the artificial conditions existing after administration of contrast medium and not under normal or physiological circumstances. Åkerlund considers the omission of the bile sedimentation and stratification test a definite technical error.

ERNST A. SCHMIDT, M.D.

## THE GASTRO INTESTINAL TRACT (DIAGNOSIS)

Essential Periduodenitis. M. E. Gabor. *Wis. Med. Jour.*, 37, 554-558, July, 1938.

Essential periduodenitis is described as that type of duodenitis due to adhesions of unknown origin. No macroscopic lesions of the gall bladder, duodenum, stomach, or appendix are encountered. The periduodenal adhesions themselves constitute the causative factor and invoke complete stenosis of the duodenum. The pathogenesis of these adhesions is debatable. Some believe them to be of congenital origin while others attribute them to inflammatory causes. The diagnosis is made only with certainty by x-ray examination. The symptoms are not characteristic. Commonly, nausea and headache are present. Vomiting may appear as a later symptom together with some loss in weight. The process is slow and progressive. An important roentgenographic sign is retention or puddling of barium in the duodenum. The duodenal bulb is irregularly shaped—referred to as the shape of a flickering candle flame. The deformity involves a large portion of the duodenum and changes contour almost constantly. Churning movements are observed and in the later stages a high degree of stenosis may be present. The treatment in the earlier stages is medical. When stenosis is present operation is indicated, some type of short circuiting operation such as duodenojejunostomy being the most suitable. One case report is included together with illustrative roentgenograms.

LESTER W. PAUL, M.D.

Two Cases of Megaduodenum. Jens Nordentoft. *Acta Radiol.*, 18, 722-732, October, 1937.

The author describes two cases of megaduodenum in patients who were operated upon at the State

Hospital of Copenhagen. The first case was that of a two-year-old girl who had been vomiting since birth. The x-ray examination showed the duodenum as large as the stomach. While the stomach emptied within two hours the 72-hour x-ray examination still demonstrated a barium residue in the duodenum. For the relief of the condition a retrocolic duodeno-jejunoscopy was performed but the etiology of the duodenal enlargement could not be definitely ascertained even after operation. The second case was that of a 25-year-old farmer whose only complaints were pains in the epigastrium, recurring periodically since childhood. Vomiting, ructus, or regurgitations had never been observed. The roentgen examination showed a normal stomach and an immensely enlarged duodenum with 48-hour barium retention. Neither the x-ray examination nor the subsequent duodeno-jejunoscopy gave any definite clues regarding the cause of the affection.

The author discusses the pathologic-etiological aspects of megaduodenum and the usual roentgen phenomena (dilatation, solid barium filling, stenotic peristalsis, antiperistalsis, Kostlivy's "tripartite paradoxal remnant," etc.

ERNST A. SCHMIDT, M.D.

Symptomless Perforations in the Gastro-intestinal Tract. R. Prevot. *Röntgenpraxis*, 10, 303-307, May, 1938.

Acute perforations in the gastro-intestinal tract are usually diagnosed clinically and not roentgenologically. The typical sign for a perforation from a roentgenological aspect is the pneumoperitoneum, visualized in standing position by the demonstration of air under the diaphragms.

Two cases are described in which perforation was proved by roentgen examination without clinical symptoms and without signs of peritoneal irritation.

It must be remembered that air below the diaphragms, that is, a pneumoperitoneum, may be found for some time after an operation, abdominal paracentesis, or tubal insufflation.

HANS W. HEFKE, M.D.

A Case of Diverticulum of the Duodenum. P. Gassmann and E. Grevillot. *Bull. et mém. Soc. Radiol. Méd. de France*, 26, 21, January, 1938.

A case of duodenal diverticulum at the level of the ampulla of Vater is presented. Examination showed that the patient had been suffering from post-prandial distress localized to this region.

S. R. BEATTY, M.D.

## GYNECOLOGY AND OBSTETRICS

Diagnosis of Placenta Previa by the Use of the Cystogram. Harley E. Anderson. *Urol. and Cutan. Rev.*, 62, 577-581, August, 1938.

The cystogram was used as an aid in diagnosing placenta previa in 22 cases of vaginal bleeding.

Placenta previa was diagnosed by x-ray and confirmed later by operation or delivery in ten cases. One case was diagnosed as positive for placenta previa by cystogram but later proved to be a normal implantation. Five cases showed negative cystograms and no evidence of placenta previa at delivery. One case showing a normal cystogram subsequently proved to be a case of pseudocyesis. Five cases of normal pregnancies were used as control. The author concludes that a careful study of the x-ray films in conjunction with the history and findings in a given case offers the best method of diagnosing placenta previa.

JOHN G. MENVILLE, M.D.

Abdominal Pregnancy at Eight Months. Philip N. Bray. *Minnesota Med.*, 21, 498-500, July, 1938.

Bray quotes Cornell and Lash who reviewed the literature on abdominal pregnancies in 1933, to find that only 35 per cent are diagnosed correctly before operation. The present case is reported because a cystogram was of material aid in diagnosis.

The patient's pregnancy history was not remarkable, and did not particularly suggest extra-uterine pregnancy. Physical examination at term appeared to reveal a mass suggesting the uterus lying in the left side of the pelvis, about the size of a three months' pregnancy, and on the right side of the abdomen a larger mass which at its superior pole suggested a fetal head.

Cystogram with 50 c.c. of 12.5 per cent sodium iodide showed the bladder distorted, its mid and left portions being flattened out, apparently by the breech. Films taken to show position of fetus showed breech presentation, with overlapping of the cranial bones, apparent collapse of the calvarium, and accentuation of the curves, taken as presumptive evidence of fetal death.

Operation revealed the fetus in essentially this position—the uterus to the left, the placenta lying above the uterus but quite distinct from it, and apparently deriving its blood supply mostly from the ommental vessels. The fetus was dead. After removal of the products of conception, the patient made an uneventful recovery.

The position of the fetus as diagnosed by routine films plus a cystogram, was essentially corroborated at operation.

PERCY JOSEPH DELANO, M.D.

The Endocrine Factors in Human Sterility: An Evaluation of Diagnostic and Therapeutic Measures. Charles Mazer, S. Leon Israel, and Charles W. Charny. *Pennsylvania Med. Jour.*, 41, 1009-1016, August, 1938.

The various causes of sterile marriages and their

treatment are given in this comprehensive article. The authors state that "the most affective single agent in the treatment of amenorrhea, as the major factor in a sterile marriage, is the irradiation of the pituitary gland and ovaries." A course of three weekly treatments of from fifty to eighty roentgen units is given to each area and is repeated in two or three months if menstrual periodicity has not been established by that time.

The authors advise that a pregnancy test be given each patient in order to avoid irradiation of an unrecognized early embryo.

JOSEPH T. DANZER, M.D.

## HEART AND VASCULAR SYSTEM

The Rôle of Mitral Stenosis and of Post-rheumatic Pulmonary Fibrosis in the Evolution of Chronic Rheumatic Heart Disease. Benjamin A. Gouley. *Am. Jour. Med. Sci.*, 196, 11-18, July, 1938.

Chronic heart failure in rheumatic heart disease has been considered to be due to the effects of mitral stenosis, causing, as a result of the stasis, chronic passive congestion and pulmonary vascular hypertension, with subsequent enlargement and eventual failure of the right ventricle.

The valvular obstruction is not the only factor leading to left auricular enlargement, and its importance in initiating the events leading to failure has probably been exaggerated. Seven instances in a series of 61 cases of mitral stenosis were found, in which, despite the presence of a stenotic mitral valve, no enlargement of the auricle had occurred. Another group was noted to have but slight enlargement of this chamber.

The chief factor which determines the severity of the course and the duration of life is the degree of right ventricular strain. This latter is, in some instances, a response to some form of pulmonary resistance, which may or may not develop in the presence of mitral stenosis.

The degree of pulmonary arterial degenerative disease, which is associated with the presence of pulmonary hypertension, is parallel to the degree of right ventricular hypertrophy and strain and to the extent of diffuse fibrosis of the lungs. Pulmonary phlebosclerosis is associated with stasis in the pulmonary veins, usually in left heart failure of whatever cause. In some cases, atherosclerosis and increased firmness of lung structure were present without mitral stenosis. In patients with mitral stenosis without cardiac disability, whose duration of life is long, atherosclerosis is usually slight.

The cause of the pulmonary hypertension is the pulmonary fibrosis, resulting from the rheumatic pneumonitis. Passive pulmonary congestion becomes important with the development of left ventricular failure.

BENJAMIN COPEMAN, M.D.

Enlargement of the Heart: Its Recognition by the Radiologic Method. Phillip Hallock. *Minnesota Med.*, 21, 303-313, May, 1938.

Hallock reviews first the normal variations, with emphasis on the hypersthenic and hyposthenic habiti, the higher diaphragm of old age, and more particularly of childhood. He warns against being misled by a scoliosis, in children of school age.

He quotes Rösler to the effect that many of the very technical methods of mensuration are not only time-consuming but misleading. He stresses the fact that absolute increase in size is not of such importance as relative increases which may speak for hypertrophy of certain chambers. Characteristic patterns of cardiac enlargement thus help one towards anetiological classification.

He reviews the routine fluoroscopic positions, suggesting that the most valuable one is that in which the patient is turned half right and examined through the left side of the chest, when evaluation of cardiac enlargement is sought. Parkinson and Bedford have described a landmark in the left oblique position of value in study of the aorta. It is the aortic triangle, a translucent triangle formed anteriorly by the left subclavian artery, posteriorly by the spine, and with the roof of the aortic arch forming its base.

If, in the left oblique position (left shoulder to screen) the posterior border of the left ventricle extends beyond the anterior shadow of the spine, it may be considered to be enlarged. It is difficult, if not impossible, to recognize hypertrophy alone by radiosopic examination; it is only when dilatation has supervened that the increased size of the left ventricle can be recognized with certainty.

The barium-filled esophagus distinguishes a persistent right-sided aortic arch by reversal of the usual indentation. The bulge formed by a left auricle increased in size is commented upon, with the warning that this is not pathognomonic for mitral stenosis. Other conditions producing this may be auricular fibrillation, heart block, and enlarged left ventricle.

The Tetralogy of Fallot often gives a characteristic cardiac silhouette, namely, a dextoposed aorta, small or normal sized pulmonary artery, and an enlarged right ventricle.

The author quotes Parkinson and Hoyle in stressing that the heart enlargement of emphysema is principally right ventricular, and that absolute measurements are misleading because of increased chest size. Right ventricular enlargement in this condition is best recognized through a study of the conus. Seen from the front, the prominence of the pulmonary artery is notable in emphysema.

Pulmonary artery enlargement should not be confused with mediastinal tumor. It is observed in patent ductus arteriosus, auricular and ventricular septal defects, and in congenital aneurysm, as well as in mitral stenosis, congestive failure, and early thyroid disease. The so-called hilar dance and pulsations of the pulmonary vessels are irrefutable evidence of pulmonary artery enlargement. PERCY JOSEPH DELANO, M.D.



Development of the Human Heart. A. Barry. *Rhode Island Med. Jour.*, 21, 76-78, May, 1938.

The author discusses a theory of the development of the human heart based on somewhat controversial, if plausible, hypotheses. He bases his theory on direct observations of preserved fetuses and on similar studies of mammalian embryos. It is of interest to note that the human heart reaches the chambered type of construction by the stage of 3.5 mm., or approximately 26 days, and that, therefore, it is possible from this time on that such functional abnormalities as partial or complete heart block may take place. Drugs in the mother's blood stream, or infections which pass the placenta may affect the developing heart at a very early stage of embryonic growth, and, through partial or temporary failure of the circulation, produce incomplete growth or differentiation in parts not closely connected with the heart.

W. H. GILLENLINE, M.D.

The Heart in Severe Anemia. C. L. Tung, W. N. Bien, and Y. C. Ch'u. *Chinese Med. Jour.*, 52, 479-500, October, 1937.

The authors, after reviewing the literature, come to the conclusion that another inherited idea, concerning the heart in anemia, deserves more careful clinical study. They have, therefore, studied ten patients suffering from severe anemia (hemoglobin 2.5 gms. per cent). Clinical, roentgenologic, and electrocardiographic studies were made. Venous pressure determinations and the arm to tongue circulation time (using saccharine) were done. Three patients showed enlarged hearts with no evidence of failure; six showed enlarged hearts with marked failure; one had a normal heart. Increase of the hemoglobin toward normal caused a rapid reduction in heart size, disappearance of diastolic cardiac murmurs and of the sinus tachycardia and large pulse pressure which represents one of the means by which the circulation is adapted to low oxygen-carrying power of the blood, that is, increased cardiac output. Rest in bed has a very favorable influence on these patients, provided the anemia is not severe, the borderline being around 50 per cent hemoglobin (normal 14.5-18.5 gms. per hundred). "Anemia heart" should be considered a clinical entity.

W. H. GILLENLINE, M.D.

Hydatid Cyst of the Heart: Peculiarities of the Roentgenologic Picture. André Blondeau, Lauprète, and Miramond de LaRoquette. *Bull. et Mém. de Radiol. Méd. de France*, 26, 194-196, March, 1938.

A case of cardio-pericardiac echinococcus cyst is presented, and the authors discuss the differential diagnosis of cardiac, pulmonary, and pleural localization.

S. R. BEATTY, M.D.

## KYMOGRAPHY

The Kymograph in Practical Roentgenology. Pleikart Stumpf. *Röntgenpraxis*, 10, 289-294, May, 1938.

The ten years since the introduction of kymography

have proved its justification as a helpful diagnostic means. The author describes the practical and technical procedures he uses for the examination of the lungs and the heart, always in connection with fluoroscopy and routine films. He believes that a heart film should always be a kymogram.

For roentgen examination of the gastro-intestinal tract he administers a very small amount of barium (2 or 3 c.c.) and watches its progress by the fluoroscope. A kymographic examination of the esophagus is done, if indicated; the time of the exposure being cut from the usual five to three seconds. The first step for the examination of the stomach is the demonstration of the mucosa relief, which is done after massaging the stomach and with a slight tilt of the body for the demonstration of the cardiac portion. Following this procedure 250 c.c. of a barium mixture are given under fluoroscopic control. Fluoroscopic observation of the peristalsis is not necessary when a kymogram is made of the stomach. In 75 per cent of the cases the movements of the emptying stomach, the pylorus, and the duodenal cap are also demonstrated. In some cases serial instantaneous spot films of pylorus and duodenum are necessary for more information. The kymographic films are examined in the kymoscope. In a considerable number of cases the author has seen pathologic kymograms which caused him to re-examine the patient with more attention to the questionable area. He succeeded thus in finding small lesions which he would have missed by the routine examination.

Kymographic examination of the small intestines should be done using an exposure time of 15 seconds. Peristalsis, contraction, and changes in the tonus may be seen in the kymoscope.

The author believes that a kymogram of the colon is of particular value. The examination time must be extended to from three to six minutes in order to demonstrate the different movements of the colon. The amount of radiation necessary in these cases (0.5 milliamper, 60 kilovolts, one meter distance) is not too large, and not greater than the radiation used for a kymogram of the stomach.

Examination of the gall bladder and the kidneys may be done with a kymograph, but there are no data available as yet for its evaluation.

The field it may occupy in examination of the spine, skeleton, joints, bronchography, arteriography, etc., has not been investigated. The author believes that it is possible that it may be of help in these fields.

HANS W. HEFKE, M.D.

## THE LUNGS

Roentgenologic Study of Paragonimiasis of Lungs. S. H. Wang and C. K. Hsieh. *Chinese Med. Jour.*, 52, 829-842, December, 1937.

The authors present the second report to be found in the literature on the clinical and experimental roentgenologic appearance of paragonimiasis. Nine human cases and a cat with this disease were studied and the x-ray appearance compared with autopsy findings. Roentgenologic appearance alone is insufficient for

demonstration. The history and clinical course give considerable help, but the presence of the ova of the parasite in the sputum is the deciding factor.

W. H. GILLENLINE, M.D.

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Radiologic Measurements of the Apico-basal Relaxation of the Lung during Artificial Pneumoperitoneum Treatment. Andrew L. Banyai. *Am. Jour. Med. Sci.*, 196, 207-211, August, 1938.

In order to determine the effects of artificial pneumoperitoneum on the elevation of the diaphragm, films were made in deep inspiration and deep expiration, and compared with similar films made before treatment was started. The basis for comparison was the linear dimension obtained by measuring the highest point of the apex of the lung from the highest point of the corresponding dome of the diaphragm.

The upward displacement of the diaphragm is influenced by (1) the tonicity and integrity of the diaphragm, (2) the tonicity of the abdominal wall, (3) pathologic changes in or about the lung, (4) the type of breathing (there is a greater tendency toward collection of subdiaphragmatic air in patients with a distinctly thoracic type of breathing than in other types), and (5) the amount of air injected.

Intraperitoneal air injections given at weekly intervals are likely to cause a sustained elevation of the diaphragm provided adhesions are not present. The author feels that the extent of elevation induced (between 6 and 7 cm.) is enough to aid in the relaxation of the lung to further healing. There was a reduction of about 30 per cent in the apico-basal length in those cases treated.

BENJAMIN COPLEMAN, M.D.

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Cavernous Hemangiomas of the Lung with Secondary Polycythemia. C. B. Rodes. *Jour. Am. Med. Assn.*, 110, 1914, 1915, June 4, 1938.

This is a report of a case of multiple hemangiomas of the lung with rupture into the bronchus. A review of the literature failed to find a record of polycythemia

complicated by hemangioma of the lung. Several reports of malignant types of hemangioma of the lung and pleura were found, as well as of both benign and malignant lesions of other viscera. The roentgenograms in this case showed findings similar to those reported in other cases, namely, nodular areas in one or the other lung-field.

CHARLES G. SUTHERLAND, M.D.

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Remarks on the Information Furnished by Tomography in Tuberculosis and Abscess of the Lung. Vaucher and Uhrig. *Bull. et mém. Soc. Radiol. Méd. de France*, 26, 38, 39, January, 1938.

It is possible, at times, to discover, by tomography, a cavity not demonstrated by ordinary radiographic methods. Tomography also permits more accurate localization of such lesions as abscess of the lung wherein the optimum surgical approach must be determined. Frequently it is only by tomography that the true condition of the thoracic structures can be demonstrated. Illustrative cases are presented in abstract.

S. R. BEATTY, M.D.

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Tuberculosis of the Azygos Lobe. H. Choussat. *Bull. et Mém. de Radiol. Méd. de France*, 26, 185-190, March, 1938.

The author discusses the diagnosis of tuberculosis of the azygos lobe and presents a case in which this lesion was well demonstrated by a therapeutic pneumothorax.

S. R. BEATTY, M.D.

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Primary Carcinoma of the Lung and Syphilis. Candido Maderno. *Arch. di Radiol.*, 14, 16-29, January-February, 1938.

Four cases are reported, all in patients with syphilis and all in workers with tar and petroleum products. The possible interrelationships of these factors in producing pulmonary cancer are discussed.

E. T. LEDDY, M.D.

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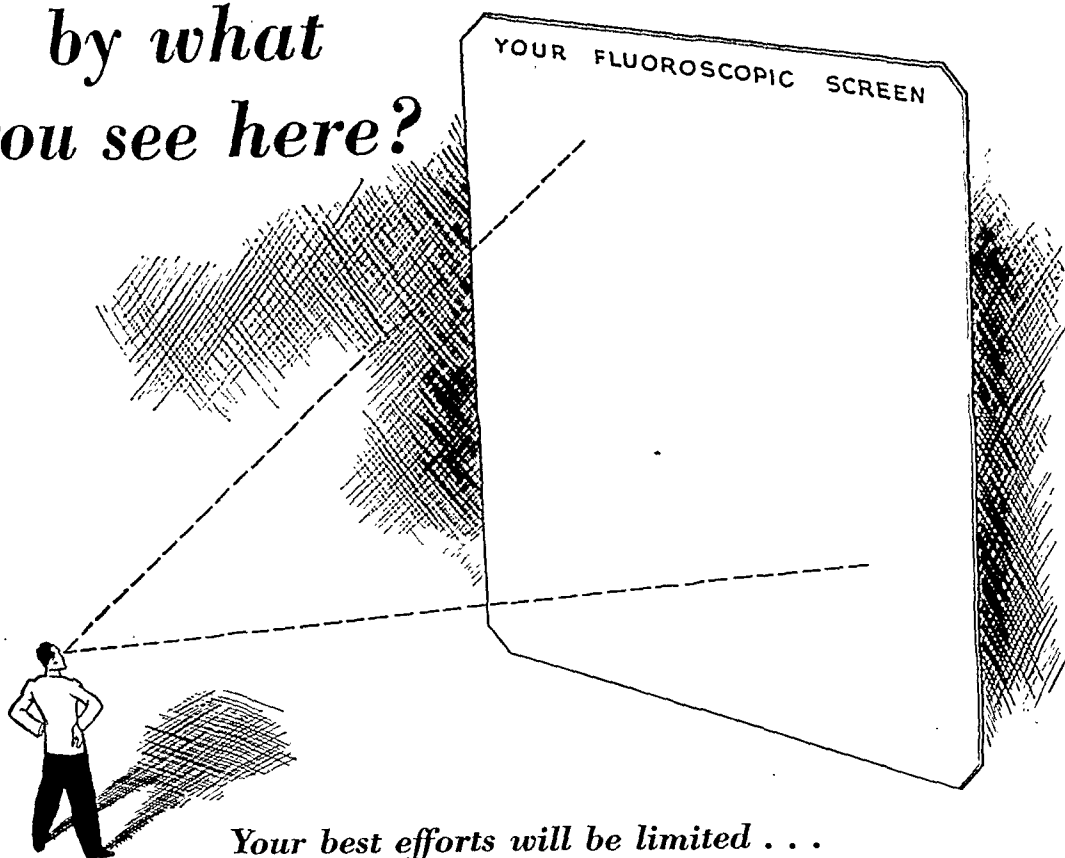
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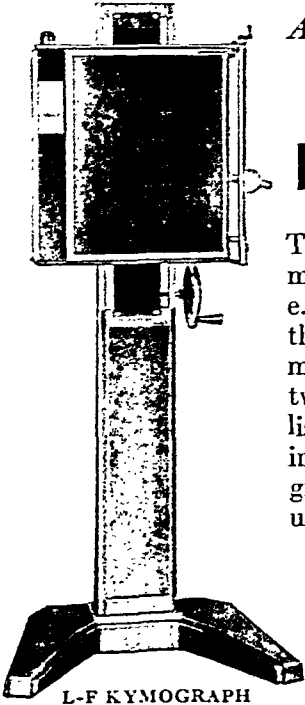


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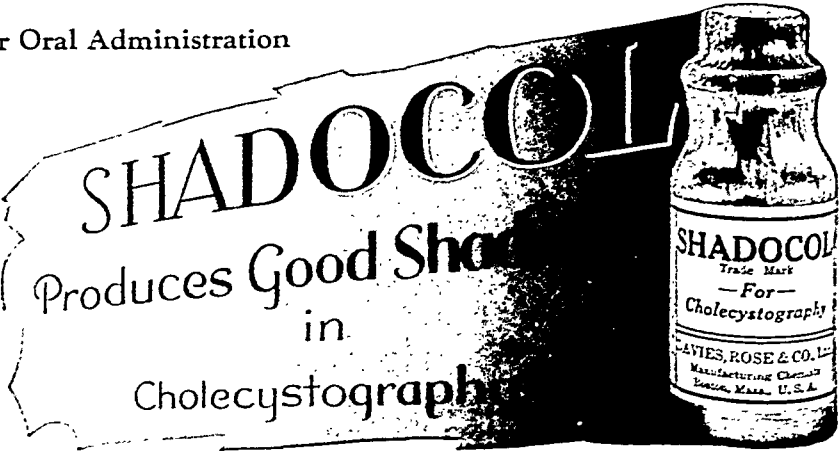
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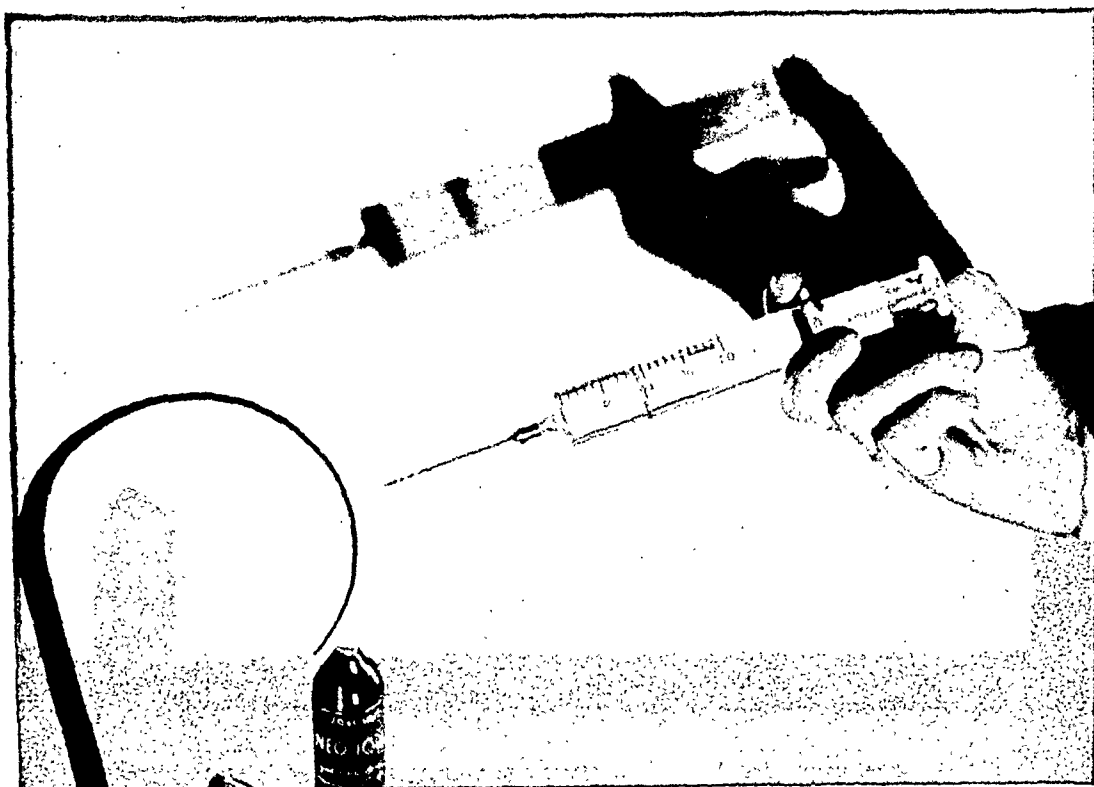
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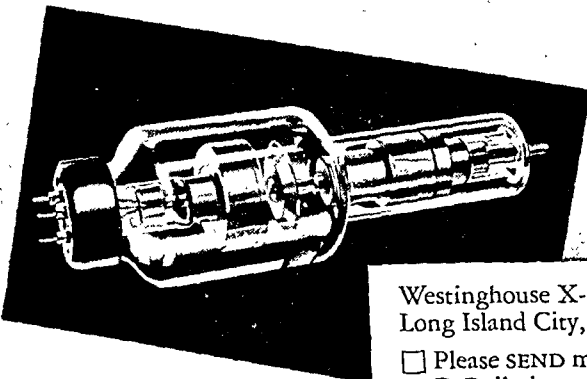
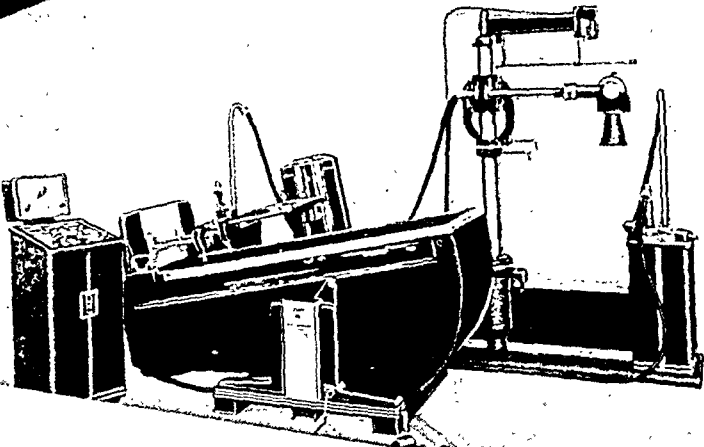
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